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Survey of the Parasitic Hymenoptera on Leafminers in California

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Abstract.—Hymenopteran parasitoids of leafminers in California are reviewed and an illustrated key to 44 genera (except Braconidae) is presented. Leafminer surveys conducted by Michael Gates (MWG) and John Heraty (JMH) between 1996 and 1999, sought to assess native parasitoid fauna in preparation for the anticipated arrival of the citrus leafminer (CLM), *Phyllocnistis citrella* Stainton, in California. These records are augmented with leafminer parasitoid rearing records of David Wagner (DLW) and Jim Whitfield (JBW) accumulated between 1979–1986. Comparison of California parasitoid fauna with CLM parasitoids from other regions would indicate which native species are likely to shift onto CLM as potential autochenous biocontrol agents. Members of the families Eulophidae, Encyrtidae, Pteromalidae, Chalcididae, Eurytomidae, Eupelmidae, Torymidae (Chalcidoidea), Bethylidae (Chrysidoidea), Braconidae, and Ichneumonidae (Ichneumonoidea) were recovered, with >80% of specimens reared belonging to Eulophidae.

This project was initially conceived and funded as a preparatory step in addressing the inevitable establishment of the citrus leafminer (CLM), *Phyllocnistis citrella* Stainton, (Lepidoptera: Gracillariidae: Phyllocnistinae) into California citrus. Eventually, the project expanded to document the identities of not only leafminers and their parasitoids reared by MWG and JMH (see below) from citrus growing regions and native biotic zones of southern California, but also numerous specimens reared by DLW and JBW, primarily from central and northern California between 1979–1986.

Parasitoids, particularly Chalcidoidea, of leafmining insects are usually generalists with respect to host or plant taxon with which they are associated (Askew and Shaw 1974). The same appears true with Ichneumonoidea, although the Braconidae appear to exhibit more specialization for a given host taxon (Shaw and Askew 1976). Additionally, idiobionts (host permanently paralyzed or killed at time of parasitoid attack) are often generalists while koinobionts (host paralyzed only during oviposition by parasitoid) are primarily specialists with Ichneumonoidea containing a higher proportion of koinobionts than Chalcidoidea (see discussion in Godfray (1994)). Those ichneumonids attacking leafminers are often facultative and, like Chalcidoidea, relatively unspecialized (Shaw and Askew 1976). Most leafminer parasitoids are niche specialists rather than host specialists and factors other than host taxonomy directly affect the degree of specialization displayed by leafminer parasitoids. These factors include host plant (phenology, chemistry, etc.), leafmine location (ab- or adaxial leaf

surface) or mine structure (tentiform, serpentine, blotch, etc.) (Askew and Shaw 1974).

The eulophid *Sympiesis sericeicornis* Nees (Hymenoptera: Eulophidae) is found on *Phyllonorycter* spp. (including *P. blancardella*) (Lepidoptera: Gracillariidae) throughout the Holarctic region (Bouček 1959a, Miller 1970, Doganlar 1980) and dominates the chalcid fauna in southern Ontario (Johnson et al. 1976, Hagley 1985). However, it is replaced in dominance by *Sympiesis marylandensis* Girault outside of Ontario (Pottinger and Leroux 1971, Maier 1984a, b, Ridgway and Mahr 1985). Maier (1988b) provided further evidence of niche (but not host) specialization during an investigation of the gracillariid hosts of *S. marylandensis* in New England, an important parasitoid of the two apple pests, *P. blancardella* and *P. crataegella*. He affirmed that *S. marylandensis* prefers abaxial mines, attacking 33 gracillariid leafminer species on 49 plant species (primarily trees, but also shrubs and herbs). Further, many agriculturally important parasitoids (including *S. marylandensis*) occur on congeneric leafminers of native cherry trees and serve as another parasitoid reservoir (Maier 1988a). Both examples illustrate the importance of native plants and leafminers as reservoirs for parasitoids important in biological control.

This study was undertaken to assess native leafminer parasitoid populations in southern California and to determine if any parasitoid species supported by native leafminers might shift to and provide fortuitous biocontrol of CLM after its arrival in California. The CLM is native to Southeast Asia, with populations extending west to the Saudi Peninsula and east to Japan (Heppner 1993). CLM spread to Australia and Africa by the early 18th century and by 1993 colonized most citrus-growing regions of the Old World. Since 1993, when CLM was first detected in Florida, it has spread throughout the Neotropics from Argentina and Mexico to southern Arizona (Heppner 1993, Knapp et al. 1995). CLM was notably absent from California citrus until 2000 (Guillén et al. 2001), when it was detected in the Imperial Valley.

Utilization of native parasitoids in the biocontrol of introduced pests is not a new concept (LaSalle and Gauld 1993, LaSalle 1993) and has many potential advantages over importing exotic parasitoids from a pest's native range: 1) the need for time-consuming and expensive foreign exploration is eliminated, 2) importation and quarantine protocols become unnecessary, 3) potential detrimental impacts of exotic parasitoid introduction upon non-target leafminers and their parasitoids is eliminated. This reservoir of native parasitoids, which can provide control of exotic pests, is one of the benefits of preserving biodiversity via habitat conservation (see discussion and references in LaSalle and Gauld 1993, LaSalle 1993, LaSalle and Peña 1997). Thus, preserving native habitats with their resident potential biocontrol agents can yield economic benefits as it pertains to a program of sustainable agriculture (LaSalle and Gauld 1993, LaSalle 1993).

Previously unnoticed native parasitoids switching to provide control of an introduced pest has been documented. Rose and DeBach (1982, 1992) found that *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae) effectively controlled the bayberry whitefly (*Parabemisia myricae* (Kuwana) (Hemiptera: Aleyrodidae)) introduced into southern California from eastern Asia. Subsequent releases of *E. debachi* successfully controlled *P. myricae* in Israel and Turkey (Rose and DeBach 1992). This example highlights not only the importance of native parasitoids in fortuitous biocontrol, but also their potential for introduction as a non-native agent in other parts of the world. In surveying native parasitoids attacking CLM in Florida, eight genera and at least eight species were recovered from CLM, 87.4% of these

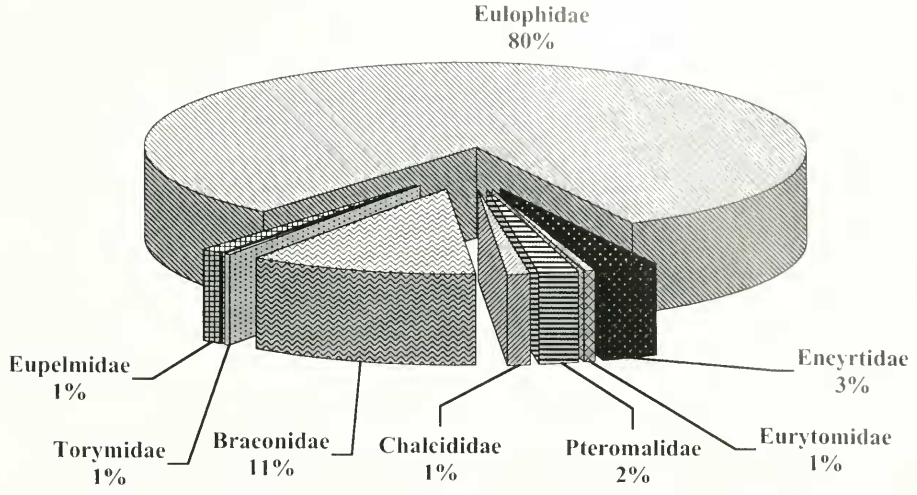


Fig. A. Proportion of chalcidoid families reared from leafminers based on number of parasitoids recovered.

belonging to Eulophidae (Peña et al. 1996). However, only *Pnigalio minio* (Walker) was present year-round; it accounted for 69–88% of all parasitoids reared between 1993–1995. Additionally, four of the same eulophid genera present in Florida were also recovered in south Texas (Legaspi and French 1996) from CLM. Survey results from California recovered all of the same genera documented from CLM in many parts of the world. Further, a new species of native eulophid parasitoid, *Cirrospilus coachellae* Gates (Gates 2000), attacks the citrus peelminer (CPM), *Marmara gulosa* Guillén and Davis (Lepidoptera: Gracillariidae) (Guillén et al. 2001), a cyclical pest of grapefruit. This eulophid has been demonstrated to be effective in reducing CPM populations in the Coachella Valley in Southern California. Colonization of *C. coachellae* is underway at the University of California at Riverside in preparation for use against CLM (Guillén, pers. comm.) and this wasp has been released against CPM in Kern County, CA where CPM has recently become problematic.

Finally, an interesting study of alternative hosts for CLM parasitoids found on the native flora in and around citrus groves in the Mediterranean region (Massa et al. 2001) indicated that presumed specialist parasitoids were in fact generalists which attacked non-target hosts. Thus, exotic released parasitoids might displace native parasitoids through direct competition, reducing the diversity of the native parasitoid resource. Little definitive documentation exists, but Bennett (1993) provides information on several biocontrol agents that have been released and appear to have displaced native parasitoids, though the evidence is not incontrovertible. A better example is presented by Viggiani (1994) in which the native parasitoid complex of the viburnum whitefly, *Aleurotuba jelinecki* (Frauenfeld) (Hemiptera: Aleyrodidae), was completely displaced in many areas in southern Italy by *Cales noacki* Howard, introduced against the woolly whitefly.

Over 80 species of parasitoids (both native and introduced species) have been recorded from CLM worldwide and appear to provide effective control in many cases (Schauff et al. 1998 and references therein). Our current study recovered Eulophidae from >80% of the 5,400 samples reared by MWG and JMH (Fig. A) with the next-largest proportion of parasitoids belonging to Braconidae. When parasitoid species accumulation is calculated across

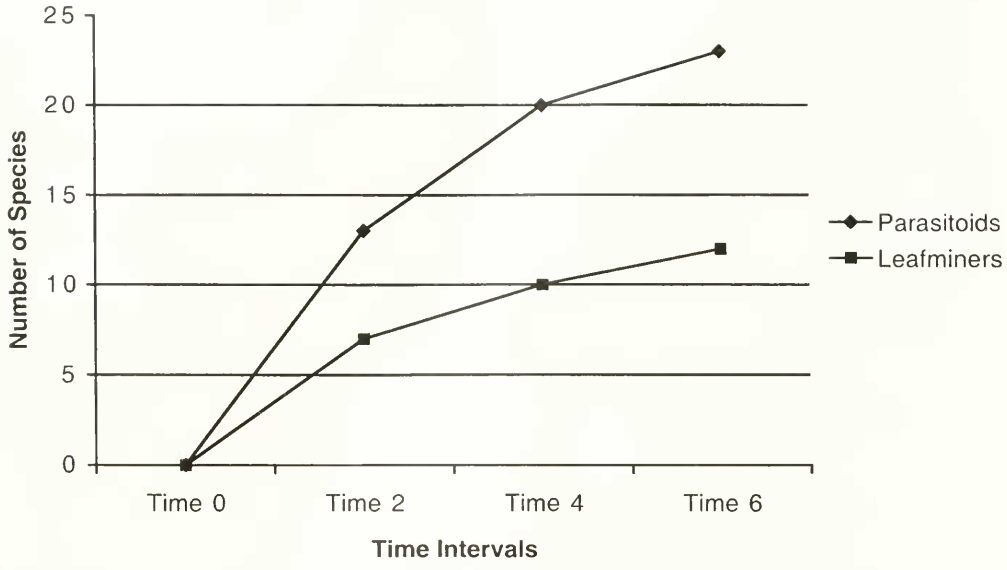


Fig. B. Species accumulation of leafminers and their parasitoids (One time interval = 6 months).

sampling time periods (Fig. B), it appears that more species remain to be recovered with continued sampling. However, these curves are based upon an arbitrary division of the sampling period of MWG/JMH into six-month blocks and serve only as a gross estimate of accumulation. Summaries of the rearing data of DLW and JBW are not included as many reared chalcidoid leafminer parasitoids were not preserved and are no longer retrievable by the authors and counts of numbers and diversity of parasitoid species would likely underestimate actual values.

MATERIALS AND METHODS

Included in Table 1 are all records of (where determined) plant hosts, leafminer hosts and parasitoids of those leafminers in California which were recovered during this study. Microhymenopteran parasitoid families and genera are summarized in Table 3, with genera of Braconidae designated by letters as they are not treated herein. An ancillary goal of this project is to allow comparisons with similar studies to be made with respect to which parasitoid genera and species are typically recovered from native leafminers, and also, which of those parasitoids are documented from CLM or could be considered likely to attack CLM.

Protocols of MWG and JMH for rearing individual leafminers are detailed below. Leafminers in their host plants were collected from field localities and placed into brown paper bags that were placed into 1 gallon Zip-Loc™ bags labeled with the locality information. This system allowed for maintenance of high humidity while inhibiting significant accumulation of condensation inside of each sample bag. Samples so prepared could be stored up to 4 days in a refrigerator with minimal loss of plant quality, which maximized leafminer and parasitoid survival. From these plant samples, individual leafmines were excised and placed into separate 4-dram shell vials and each vial was tightly plugged with cotton. Each vial received a unique alphanumeric code that was placed in the vial with the sample and each code was recorded in a project notebook. Vials were then inserted into the 1 cm^2 spaces in plastic grids designed to fit fluorescent lighting fixtures common in

Table 1. Hymenopterous parasitoids reared from native leafminers in California.

Plant family/species	Guild	Leafminer	Parasitoids
Anacardiaceae			
Rhus integrifolia (Nutt.)	USS[1]	*Stigmella rhoifoliella* (Braun)	*Closterocerus utahensis* Crawford†
Rhus diversiloba T. and G.	LSBM/LR	*Caloptilia diversilobiella* Opler	*Sympiesis marylandensis* Girault, *Goniozus* sp., *Pholetesor bedelliae* (Viereck), *Pholetesor salicifoliellae* (Mason). *Bathythrix latifrons* (Cushman)‡
Rhus ovata S. Watson	USBM/LR	*Caloptilia ovatiella* Opler	*Pholetesor salalicus* (Mason)‡
Asteraceae			
Arnica parryi A. Gray	LSBM	*Acrocercops* sp.	*Mesochorus* sp.‡
Artemisia douglasiana Besser	USS/B	Unknown	*Chrysocharis ainsliei* Crawford, *Aprostocetus* sp.†
Artemisia douglasiana Besser	CS/E	*Bucculatrix* sp.	*Paroligoneurus* sp., *Pholetesor* n. sp. 4‡
Artemisia douglasiana Besser	LSBM	*Cremastobombycia* n. sp.	*Apanteles* sp., *Colastes* sp.‡
Artemisia suksdorfi Piper		"leaf miner"	*Pholetesor salalicus* (Mason)‡
Artemisia tridentata Nutt.	CS/E	*Bucculatrix* sp.	*Deuterixys pacifica* Whitfield, *Gelis* sp. 3 (fem), *Gelis* sp. 4 (male)‡
Artemisia tridentata Nutt.	CS/E	*Bucculatrix* sp.	*Pholetesor bedelliae* (Viereck)‡
Artemisia sp.		?Agromyzidae	*Brachymeria* sp.†
Artemisia sp.	LSBM	*Cremastobombycia* sp.	*Puigalio* sp.‡
Aster chilensis Nees	FDBM	*Coleophora* sp.	*Mesopolobus* sp.‡
Aster sp.	USS	*Calycomyza* sp., *Liriomyza* sp.	*Diglyphus* sp.‡
Aster sp.	FDBM	*Tischeria* sp.	*Puigalio flavipes* (Ashmead), *Aprostocetus* sp., *Chrysocharis* sp., *Sympiesis stigmata* Girault, *Apanteles* sp., *Zagrammosoma mirum* Girault‡
Baccharis pilularis DC.	CS/E	*Bucculatrix variabilis* Braun	*Pholetesor* n. sp. 4, *Pholetesor* n. sp. 2, *Deuterixys pacifica* Whitfield, *Stiropius californicus* Whitfield‡
Baccharis pilularis DC.	CS/E	*Bucculatrix dominatrix* Rubinoff and Osborne	*Pholetesor* n. sp. 2‡
Baccharis pilularis DC.	LSBM	*Cremastobombycia* sp.	*Apanteles* sp.‡
Baccharis salicifolia (R. Lopez and Pavón)	USS	*Bucculatrix* sp. or Agromyzidae	*Sympiesis marylandensis* Girault, *Chrysocharis ainsliei* Crawford†
Baccharis sp.	CS/E	*Bucculatrix* sp.	*Gelis* sp. 6 (fem), *Gelis* sp. 1 (male), *Gelis* sp. 2 (fem)‡
Baccharis sp.	CS/E	*Bucculatrix* ?*variabilis* Braun	*Gelis* sp. 1 (male) *Gelis* sp. 2 (fem)‡
Brickellia sp.	FDBM	*Tischeria* sp.	*Apanteles* sp.‡
Bidens pilosa L.	USS	*Liriomyza* sp.	*Diglyphus begini* (Ashmead), *Closterocerus cinctipennis* Ashmead, *C. utahensis* Crawford, *Chrysocharis* sp.†
Cirsium vulgare (Savi)	USS	*Liriomyza* sp.	*Closterocerus* sp., *Closterocerus* poss. *submutica* Graham†
Eucelia californica Nutt.	CS/E	*Bucculatrix* sp.	*Apanteles* sp.‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Eucelia californica Nutt.	LSBM	*Acrocercops* sp.	*Apanteles* sp.‡
Eucelia farinosa Gray	USS/B	*Calycomyza eucleiae* Spencer	*Pnigalio maculipes* (Crawford)†
Gnaphalium sp.	?LSBM	?*Cremastobombycia* sp.	*Dolichogenidea* sp.‡
Grindelia sp.	USBM	*Cremastobombycia grindeliella* Wlsm.	*Pnigalio* ?sp., *Aprostocetus* sp.‡
Helianthus annuus L.	USS	*Calycomyza eucleiae* Spencer	*Chrysocharis ainslici* Crawford, *Pnigalio flavipes* (Ashmead)†
Iva axillaris Pursh.	CS/E	*Bucculatrix* sp.	*Deuterixys pacifica* Whitfield‡
Silybum marianum Gaertn.	CS/B	*Liriomyza* sp.	*Diglyphus begini* (Ashmead)†
Solidago sp.	LSBM	*Acrocercops* sp.	*Pholetesor bedelliae* (Viereck)‡
Sonchus oleraceous L.	CS	*Chromatomyia syngenesiae* Hardy	*Pediobius acantha* (Walker), *Pnigalio coloni* (Girault), *Chrysocharis ainslici* Crawford, *Diglyphus begini* (Ashmead), *Closterocerus* sp.†
Venegasia carpesioides DC	CS	Agromyzidae	*Colastes* n. sp., *Diglyphus begini* (Ashmead)†
Wyethia mollis A. Gray	CS/E	*Bucculatrix divisa* Braun	*Pholetesor bedelliae* (Viereck)‡
Xanthium strumarium L.	USS	*Calycomyza* sp.	*Thinodytes caroticus* Heydon, *Pnigalio boliarti* Yoshimoto, *Chrysocharis ainslici* Crawford, *Halticoptera* sp., *Sympiesis marylandensis* Girault†
Berberidaceae			
Berberis pinnata Lagasca	USS	*Stigmella* sp.	*Colastes* sp.‡
Betulaceae			
Alnus rhombifolia Nutt.	USS/B		*Closterocerus utahensis* Crawford†
Alnus rubra Bong.	USBM	*Phyllonorycter incana* (Walsm.)	*Pholetesor salicifoliellae* (Mason), *Mesochorus* sp., *Pnigalio* sp.‡
Alnus tenuifolia Nutt.	USBM or LSBM/LR	*Caloptilia alnivorella* (Chambers)	*Apanteles* sp., *Pholetesor salicifoliellae* (Mason)‡
Alnus tenuifolia Nutt.	USBM or LSBM	*Phyllonorycter* sp.	*Colastes* sp.‡
Betula fontinalis Sargent	LSBM≫LS	*Parornix* sp.	*Pholetesor salalicus* (Mason), *Pholetesor salicifoliellae* (Mason)‡
Corylus cornuta Marsh.	LSBM	*Phyllonorycter* sp.	*Rhysipolis decorator* (Haliday)‡
Bignoniaceae			
Chilopsis linearis (Cav.)	USS/B		*Closterocerus utahensis* Crawford†
Buxaceae			
Simmondsia chinensis (Link.)	CB	?*Periploca* sp.	*Bassus calcaratus* (Cresson), *Trichomalopsis* sp., *Sympiesis stigmata* Girault, *Sympiesis* ?*acrobasidis* Miller, *Sympiesis* ?*sericicornis* (Nees)†
Brassicaceae			
Hirschfeldia incana (L.)	USS	*Liriomyza* sp.	*Colastes* n. sp., *Diglyphus begini* (Ashmead), *Euderus* sp., *Chrysocharis* sp.†

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Caprifoliaceae			
Lonicera hispidula Douglas	FDBM	*Perittia passula* Kaila	*Apanteles* sp.‡
Lonicera hispidula Douglas	LSBM	*Phyllonorycter* sp.	*Colastes* sp.‡
Lonicera sp.	LSBM	*Phyllonorycter* sp.	*Apanteles* sp.‡
Lonicera subspicata H and A or *Symphoricarpos mollis* Nutt.	USS/B	Agromyzidae	*Diglyphus begini* (Ashmead)†
Symphoricarpos mollis Nutt.	FDBM	*Perittia* sp.	*Apanteles* sp.‡
Symphoricarpos mollis Nutt.	LSBM	*Phyllonorycter* sp.	*Apanteles* sp., *Colastes* sp., *Parahormius* sp.‡
Symphoricarpos albus (L.)	LSBM	*Phyllonorycter* sp.	*Pholetesor salicifoliellae* (Mason)‡
Symphoricarpos sp.	LSBM	*Phyllonorycter* sp.	*Encrateola* sp., *Pimpla* sp., *Gelis* sp. 2 (fem)‡
Convolvulaceae			
Convolvulus arvensis L.	FDBM	*Bedellia somnulentella* (Zeller)	*Parahormius* sp., *Gelis* sp. 2 (fem), *Pholetesor bedelliae* (Viereck)‡
Cornaceae			
Cornus sp.	FDBM	*Antispila aurirubra* Braun	*Pnigalio flavipes* (Ashmead), *Pediobius albipes* (Provancher), *Colastes* sp.‡
Cucurbitaceae			
Cucumis mello L.	USS/B	*Liriomyza sativae* Blanchard	*?Neochrysocharis* sp.†
Cucurbita foetidissima HBK	USS/B	Agromyzidae	*Diaulinopsis callichroma* Crawford, *Diglyphus begini* (Ashmead), *Neochrysocharis diastatae* (Howard), *Neochrysocharis arizonensis* (Crawford), *Thinodytes caroticus* Heydon†
Cyperaceae			
Carex sp.	USS/FDBM	*Elachista* sp.	*Pholetesor bedelliae* (Viereck), *Colastes* sp.‡
Datiscaceae			
Datisca glomerata (Presl.)	CS	*Liriomyza* sp.	*Pnigalio coloni* Girault, *Chrysocharis oscinidis* Ashmead, *Halticoptera* sp., *Spalangia* sp., *Gonatocerus* (!?), Encyrtinae, *Closterocerus cincinnatus* Girault, *Brasema ?macrocarpae* (Ashmead)†
Ericaceae			
Arbutus menziesii Pursh.	USS/FDBM	*Coptodisca arbutiella* Busck	*Closterocerus trifasciatus* Westw., *Sympiesis* sp., *Chrysocharis* sp., *Mirax ectoedemiae* (Rohwer)†
Arbutus menziesii Pursh.	USS	*Marmara arbutiella* Busck	*Apanteles* sp., *Mirax ectoedemiae* (Rohwer)†
Arbutus menziesii Pursh.	LSBM or USBM	*Phyllonorycter arbutusella* Braun	*Sympiesis stigmata* Girault, *Chrysocharis* sp., *Neochrysocharis* ?sp., *Achrysocharoides ?zwoelferi* (Delucchi)‡
Arctostaphylos columbiana Piper	USBM or LSBM	*Phyllonorycter ?manzanitae* Braun	*Colastes* sp., *Pholetesor salalicus* (Mason)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Arctostaphylos glauca Lindl.	USS	?Gelechiidae	*Torymus* sp., *Eupelmus* sp.†
Arctostaphylos manzanita C. Parry	CS/FDBM	*Coptodisca ?arbutiella* Busck	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos patula E. Greene	USS	*Marmara arbutiella* Busck	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos stansfordiana C. Parry	CS/FDBM	*Coptodisca ?arbutiella* Busck	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos virgata Eastw.	CS/FDBM	*Coptodisca ?arbutiella* Busck	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos virgata Eastw.	USBM or LSBM	*Phyllonorycter manzanitae* Braun	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos sp.	CS/FDBM	*Coptodisca ?arbutiella* Busck	*Mirax ectoedemiae* (Rohwer)‡
Arctostaphylos sp.	USBM or LSBM	*Phyllonorycter manzanitae* Braun	*Apanteles* sp., *Neochrysocharis* sp., *Sympiesis stigmata* Girault, *Pnigalio flavipes* (Ashmead), *Mirax ectoedemiae* (Rohwer), *Pholetesor salalicus* (Mason)‡
Arctostaphylos sp.	CS/FDBM	*Coptodisca ?arbutiella* Busck	*Chrysocharis* sp.‡
Gaultheria shallon Pursh.	USBM	*Cameraria gaultheriella* Wlsm.	*Ageniaspis bicoloripes* (Girault), *Chrysocharis* sp., *Colastes* sp., *Pholetesor salalicus* (Mason), *Pholetesor* n. sp. 3‡
Kalmia polifolia Wangenh.	LSBM	*Phyllonorycter* n. sp.	*Pholetesor salalicus* (Mason)‡
Ledum glandulosum Nutt.	USBM	*Phyllonorycter ledella* Wlsm.	*Achrysocharoides ?zwoelferi* (Delucchi), *Colastes* sp.‡
Rhododendron occidentale (Torrey and Gray)	CS/FDBM	*Lyonetia candida* Braun	*Pnigalio flavipes* (Ashmead)‡
Rhododendron occidentale (Torrey and Gray)	LSBM/LS	*Caloptilia ferruginella* (Braun)	*Pholetesor salalicus* (Mason), *Pholetesor salicifoliellae* (Mason)‡
Rhododendron (ornamentals)	LSBM/LS	*Caloptilia azaleella* (Braun)	*Pholetesor salalicus* (Mason)‡
Rhododendron sp.	CS/FDBM	*Lyonetia latistrigella* Wlsm.	*Closterocerus trifasciatus* Westwood, *Sympiesis marylandensis* Girault‡
Vaccinium ovatum Pursh.	USBM	*Cameraria nemoris* (Walsm.)	*Colastes* sp., *Pholetesor salalicus* (Mason)‡
Vaccinium sp.	USBM	*Cameraria nemoris* (Walsm.)	*Achrysocharoides ?zwoelferi* (Delucchi)‡
Fabaceae			
Lathyrus sp.	LSBM	*Phyllonorycter* nr *memorabilis* (Wlsm.) or *Protolithocolletis lathyri* Braun	*Pholetesor salicifoliellae* (Mason), *Colastes* sp.‡
Lathyrus sp.	B		*Gelis* sp. 3 (male)‡
Lotus scoparius (Nutt.)	SSM	*Microcalyptris lotella* Wagner	*Chelonus* sp., *Mirax ectoedemiae* (Rohwer)‡
Lotus sp.		"leafminer"	*Parahormius* sp.‡
Medicago sativa L.	CS	*Liriomyza sativae* Blanchard	*Diaulinopsis callichroma* Crawford, *Closterocerus cincinnatus* Girault, *C utahensis* Crawford, *Achrysocharoides ?zwoelferi* (Delucchi), *Neochrysocharis arizonensis* (Crawford), *Chrysocharis* sp.†

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Fagaceae			
Chrysolepis chrysophalla (Hook.)	LSBM	*Phyllonorycter* n. sp.	*Chrysocharis* sp., *Pnigalio* sp., *Pholetesor salalicus* (Mason)‡
Chrysolepis chrysophalla (Hook.)	USBM	*Cameraria tildeni* Opler and Davis	*Pholetesor salalicus* (Mason)‡
Chrysolepis sempervivens (Hook.)	USBM	*Cameraria sempervirensella* Opler and Davis	*Pholetesor salalicus* (Mason)‡
Chrysolepis sempervirens (Kellogg)	LSBM	*Phyllonorycter* n. sp.	*Pholetesor salalicus* (Mason)‡
Lithocarpus densiflorus Hook and Arn.	LSBM	*Phyllonorycter* n. sp.	*Pholetesor salalicus* (Mason)‡
Lithocarpus densiflorus Hook and Arn.	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer), *Paradelius rubra* Whitfield‡
Quercus agrifolia Nee	USBM	*Acrocercops insulariella* Opler	*Pholetesor salalicus* (Mason)‡
Quercus agrifolia Nee	CS/E	*Bucculatrix albertiella* Busck	*Cantharoctonus* sp., *Deuterixys quercicola* Whitfield, *Pholetesor bucculatricis* (Muesebeck), *Pholetesor* n. sp. 4, *Gelis* sp. 2 (fem), *Gelis* sp. 4 (fem), *Gelis* sp. 5 (fem), *Gelis* sp. 1 (male), *Gelis* sp. 4, *Gelis* sp. 5 (male)‡
Quercus agrifolia Nee	LSBM or USBM/LS	*Caloptilia reticulata* (Braun)	*Dolichogenidea* sp., *Campoplex* sp.‡
Quercus agrifolia Nee	USBM	*Cameraria agrifoliella* (Braun)	*Pholetesor salalicus* (Mason)‡
Quercus agrifolia Nee	USS	*Stigmella variella* (Braun)	*Mirax ectoedemiae* (Rohwer), *Paradelius rubra* Whitfield, *Parahormius* sp.‡
Quercus agrifolia Nee.	USS	*Stigmella ?variella* (Braun)	*Dolichogenidea tischeriae* (Viereck)‡
Quercus agrifolia Nee.	USBM	*Cameraria agrifoliella* (Braun)	*Sympiesis marylandensis* Girault, *Pnigalio flavipes* (Ashmead), *Cirrospilus* sp., *Aprostocetus* sp.‡
Quercus agrifolia Nee	USBM	*Cameraria wislizeniella* Opler	Encyrtinae, *Chrysocharis* sp., *Sympiesis marylandensis* Girault‡
Quercus agrifolia Nee	USBM or LSBM/LR	*Caloptilia* sp.	*Campoplex* sp., *Scambus hirticauda* (Provancher)‡
Quercus agrifolia Nee	LSBM	*Phyllonorycter* sp.	*Sympiesis* sp., *Chrysocharis* sp., *Pnigalio levis* Yoshimoto, *Horismenus fraternus* (Fitch), *Ageniaspis bicoloripes* (Girault)†
Quercus agrifolia Nee	MVT/FDBM	*Neurobathra bohartiella* Opler	*Euderus* sp., *Chrysocharis* sp., *Sympiesis marylandensis* Girault, *Cirrospilus flavicinctus* Riley, *Neochrysocharis* sp.‡
Quercus agrifolia Nee	USS	*Stigmella variella* (Braun)	*Chrysocharis* sp., *Parablastothrix nearctica* Miller, *Sympiesis* sp.‡
Quercus agrifolia Nee	USS/FDBM	*Tischeria discreta* Braun	*Conura* sp.‡
Quercus alba L.	LSBM	*Phyllonorycter* sp.	*Pediobius* sp.‡
Quercus alba L.	USS/FDBM	*Tischeria* sp.	*Chrysocharis* sp.‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Quercus alvordiana Eastw.	USS/FDBM	*Tischeria* sp.	*Aprostocetus* sp., *Conura side* (Walker), *Miotropis californicus* Girault‡
Quercus arizonica Sarg.	USS/FDBM	*Tischeria arizonica* Braun	*Chrysocharis* sp., *Sympiesis stigmata* Girault, *Horismenus fraternus* (Fitch), *Closterocerus cinctipennis* Ashmead, *Puigalio uroplatae* (Provancher), *Closterocerus* sp.‡
Quercus chrysolepis Liebm.	LSBM	*Phyllonorycter* sp.	*Achrysocharoides villosus* Kamijo, *Hemiptarsenus* sp., *Pediobius* sp., *Chrysocharis* sp.†
Quercus chrysolepis Liebm.	USBM	*Cameraria diabloensis* Opler and Davis	*Sympiesis marylandensis* Girault, *Chrysocharis* sp., *Ageniaspis bicoloripes* (Girault)†
Quercus chrysolepis Liebm.	LSBM	*Phyllonorycter leucothorax* (Wlsm.)	*Chrysocharis* sp.‡
Quercus chrysolepis Liebm.	USS	*Stigmella* sp.	*Gelis* sp. 4 (fem), *Mirax ectoedemiae* (Rohwer)‡
Quercus chrysolepis Liebm.	USBM	*Cameraria shenaniganensis* Opler and Davis	*Eupelmus* sp., Pteromalinae, Tetrastichinae‡
Quercus chrysolepis Liebm.	LSBM	*Acrocercops* n. sp.	*Bassus calcaratus* (Cresson)†
Quercus chrysolepis Liebm.	LSBM/LR	*Caloptilia* sp.	*Dolichogenidea* sp.†
Quercus chrysolepis Liebm.	USBM	*Cameraria* sp.	*Pholetesor salalicus* (Mason)‡
Quercus chrysolepis Liebm.	LSBM	*Phyllonorycter* sp.	*Pholetesor salalicus* (Mason)‡
Quercus chrysolepis Liebm.	FDBM	*Stilbosis dulcedo* (Hodges)	*Chelonus* sp., *Mirax ectoedemiae* (Rohwer), *Baryscapus* sp.†
Quercus douglasii Hook and Arn.	CS/E	*Bucculatrix* sp.	*Stiropius californicus* Whitfield‡
Quercus douglasii Hook and Arn.	CS/E	*Bucculatrix zophopasta* Braun	*Pholetesor* n. sp. 4‡
Quercus douglasii Hook and Arn.	USBM	*Cameraria pentekes* Opler and Davis	*Pholetesor salalicus* (Mason)‡
Quercus dumosa Nutt.	LSBM/LR	*Caloptilia* sp.	*Bassus calcaratus* (Cresson)†
Quercus dumosa Nutt.	USBM	*Cameraria* sp.	*Mirax ectoedemiae* (Rohwer), *Pholetesor salalicus* (Mason), *Closterocerus ?cincinnatus* Girault‡
Quercus dumosa Nutt.	LSBM	*Phyllonorcyter* sp.	*Mirax ectoedemiae* (Rohwer), *Pholetesor salalicus* (Mason)‡
Quercus dumosa Nutt.	USS	*Stigmella* sp.	*Paradelius rubra* Whitfield‡
Quercus dumosa Nutt.	USBM	*Cameraria jacintoensis* Opler and Davis	Encyrtinae, *Achrysocharoides ?zwoelferi* (Delucchi), *Aprostocetus* sp.‡
Quercus dumosa Nutt.	USS/FDBM	*Tischeria consanguinea* Braun	*Sympiesis marylandensis* Girault‡
Quercus dunnii Kellogg	USBM	*Cameraria* nr. *tembloreusis* Opler and Davis	*Horismenus* sp., *Chrysocharis* sp., *Cirrospilus cinctithorax* (Girault), *Chrysocharis* sp.‡
Quercus durata Jepson	LSBM	*Phyllonorycter* n. sp.	*Pholetesor salalicus* (Mason)‡
Quercus durata Jepson	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer)‡
Quercus ?falcata Michx.	USS/FDBM	*Tischeria* sp.	Pteromalinae‡
Quercus garryana Hook	USS/FDBM	*Tischeria* sp.	*Puigalio* sp.‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Quercus garryana Hook	CS/E	*Bucculatrix zophopasta* Braun	*Pholetesor* n. sp. 4‡
Quercus garryana Hook	LSBM	*Phyllonorycter basistrigella* (Clemens)	*Pholetesor salalicus* (Mason)‡
Quercus glaucoides Martens and Galeotti	USS/FDBM	*Tischeria purinosella* Cham.	*Sympiesis marylandensis* Girault, *Horismenus* sp., *Baryscapus* sp., *Closterocerus trifasciatus* Westwood‡
Quercus glaucoides Martens and Galeotti	USS/FDBM	*Tischeria quercitella* Clem.	*Chrysocharis* sp.‡
Quercus kelloggii Newb.	USBM	*Cameraria mediodorsella* (Braun)	*Pnigalio ?uroplatae* (Howard), *Pholetesor salalicus* (Mason)‡
Quercus kelloggii Newb.	FDBM	*Eriocraniella aurosparsella* (Wlsm.)	*Sympiesis* sp.‡
Quercus kelloggii Newb.	LSBM	*Acrocercops* n. sp.	*Stiropius wagneri* Whitfield‡
Quercus kelloggii Newb.	CS/E	*Bucculatrix* sp.	*Pholetesor bucculatricis* (Muesebeck)‡
Quercus lobata Nee	CS/E	*Bucculatrix* sp.	*Deuterixys quercicola* Whitfield‡
Quercus lobata Nee	LSBM	*Phyllonorycter* sp.	*Pholetesor salalicus* (Mason), *Pholetesor salicifoliellae* (Mason)‡
Quercus lobata Nee	USS	*Stigmella* sp.	*Adelius* sp.‡
Quercus lobata Nee	USS/FDBM	*Tischeria consanguinea* Braun	*Pholetesor salalicus* (Mason)‡
Quercus lobata Nee	USBM	*Cameraria lobatiella* Opler and Davis	*Pteromalus* ?sp.‡
Quercus nigra L.	USS/FDBM	*Tischeria* sp.	*Pnigalio flavipes* (Ashmead)‡
Quercus ?nigra L.	USS/FDBM	*Tischeria* sp.	*Pnigalio* sp.‡
Quercus rubra	CS/E	*Bucculatrix ainsliella* Murtfeldt	*Pediobius* sp.‡
Quercus stellata Wang.	USS/FDBM	*Tischeria ?fuscomarginella* Cham.	*Chrysocharis* sp.‡
Quercus stellata Wang.	USS/FDBM	*Tischeria simulata* Braun	*Zagrammosoma multilineatum* (Ashmead), *Horismenus* sp., *Sympiesis marylandensis* Girault‡
Quercus texana Buckley	USS/FDBM	*Tischeria* sp.	*Sympiesis marylandensis* Girault‡
Quercus turbinella Greene	USBM	*Cameraria* sp.	*Dolichogenidea tischeriae* (Viereck), *Elachertus cacoecia* (Howard), *Zagrammosoma centrolineatum* Crawford, *Pholetesor salalicus* (Mason)‡
Quercus vaccinifolia Kellogg	USBM	*Cameraria* n. sp.	*Cirrospilus flavoviridis* Crawford, *Pnigalio flavipes* (Ashmead), *Pnigalio boharti* Yoshimoto, *Pnigalio maculipes* (Crawford), *Pnigalio brachysellus* Yoshimoto, *Sympiesis dolichogaster* Ashmead, *Mesopolobus* sp., *Ageniaspis bicoloripes* (Girault), *Sympiesis* sp., *Chrysocharis* sp., *Pholetesor salalicus* (Mason)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Quercus wislizenii A. DC.	USBM	*Cameraria wislizeniella* Opler	*Pholetesor salalicus* (Mason), *Pholetesor* n. sp. 3‡
Quercus wislizenii A. DC.	LSBM	*Phyllonorcyter* sp.	*Pholetesor salalicus* (Mason)‡
Quercus wislizenii A. DC.	USS	*Stigmella* sp.	*Gnamptodon* sp.‡
Quercus wislizenii A. DC.	USBM	*Cameraria wislizeniella* Opler	*Pholetesor salalicus* (Mason), *Sympiesis marylandensis* Girault
Quercus wislizenii A. DC.	USBM	*Cameraria* prob. *wislizeniella* Opler	*Sympiesis marylandensis* Girault, *Ageniaspis bicoloripes* (Girault), *Pnigalio levis* Yoshimoto, *Achrysocharoides ?laticollaris* Kamijo†
Quercus sp.	USS/FDBM	*Tischeria citrinipennella* Clem.	*Chrysocharis* sp., *Pnigalio* sp.‡
Quercus sp.	USS/FDBM	*Tischeria zelleriella* Cham.	*Pnigalio* sp., *Zagrammosoma multilineatum* (Ashmead), *Chrysocharis* sp., *Pediobius* sp.‡
Quercus sp.	USBM	*Cameraria* sp.	*Chartocerus* sp.†
Quercus sp.	CS/FDBM	*Coptodisca powellella* Opler	*Chrysocharis* n. sp.†
Grossulariaceae			
Ribes sanguineum Pursh.	LSBM/LS	*Caloptilia* sp.	*Pholetesor salalicus* (Mason)‡
Ribes sanguineum Pursh.	LSBM	*Phyllonorycter ribefoliae* (Braun)	*Colastes* sp., *Pholetesor salicifoliellae* (Mason), *Sympiesis marylandensis* Girault, *Closterocerus* sp., *Achrysocharoides ?zwoelferi* (Delucchi)‡
Ribes sp.	LSBM	*Phyllonorycter ribefoliae* (Braun)	*Chrysocharis ainsliei* Crawford‡
Hydrophyllaceae			
Eriodictyon trichocalyx Heller	FDBM	*Coelopoeta glutinosi* (Wlsm.) and Agromyzidae (both may be mining)	*Zagrammosoma hobbesi* LaSalle, *Dolichogenidea tischeriae* (Viereck), *Microdontomerus anthonomi* Crawford, *Conura side* (Walker), *Bassus cinctus* (Cresson), *Chrysocharis ainsliei* Crawford, *Neochrysocharis* sp., *Diglyphus begini* (Ashmead), *Closterocerus cinctipennis* Ashmead/*utahensis* Crawford (male)†
Eriodictyon crassifolium Benth.	FDBM	*Coelopoeta glutinosi* (Wlsm.)	*Diglyphus begini* (Ashmead), *Goniozus* sp., *Chrysocharis ainsliei* Crawford†
Eriodictyon crassifolium Benth.	USS	*Phytomyza* sp.	*Closterocerus utahensis* Crawford†
Phacelia sp.	FDBM	*Coelopoeta* n. sp.	*Conura* sp., *Parahormius* sp.‡
Phacelia sp.	FDBM	*Coelopoeta* n. sp.	*Zagrammosoma hobbesi* LaSalle‡
Lamiaceae			
Lepechinia calycina (Benth.)	CS/E	*Bucculatrix* sp.	*Stiropius californicus* Whitfield‡
Lepechinia calycina (Benth.)	LSBM	*Cremastobombycia* n. sp.	*Pholetesor salalicus* (Mason)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Salvia mellifera Greene	USS	*Liriomyza* sp.	*Diglyphus begini* (Ashmead), *Lyrcus justicia* (Girault) [?]†
Lauraceae			
Umbellularia californica (HandA)	USBM/LS	*Caloptilia* sp.	*Sympiesis dolichogaster* (Ashmead)‡
Liliaceae			
Smilax sp.	FDBM	*Proleucoptera smilaciella* (Bsk.)	*Aprostocetus* sp.‡
Yucca baccata Torrey	Stalk borer	*Prodoxus coloradensis* Riley	*Eupelmus* sp.‡
Malvaceae			
Gossypium sp.	USS		*Diglyphus begini* (Ashmead)†
Malacothamnus sp.	USS/FDBM	*Tischeria* sp.	*Dolichogenidea tischeriae* (Viereck), *Neochrysocharis ?diastatae* (Howard)†
Sidalcea sp.	USS/FDBM	*Tischeria omissa* Braun	*Sympiesis stigmata* Girault, *Aprostocetus* sp.‡
Malacothamnus sp.	CB	*?Tischeria* sp.	*Pholetesor salalicus* (Mason), *Conura side* (Walker), *Sympiesis stigmata* Girault†
Myriaceae			
Myrica californica Cham.	USBM	*Cameraria umbellulariella* (Wlsm)	*Pholetesor salalicus* (Mason)‡
Myrica californica Cham.	USS	*Marmara* sp.	*Mirax ectodemiae* (Rohwer)‡
Nyctaginaceae			
Abronia umbellata Lam.	FDBM	*Nealyda* n. sp.	*Zagrammosoma* ?n. sp.†
Mirabilis sp.	FDBM	Unidentified microlep.	*Chelonus* sp.†
Onagraceae			
Oenothera californica Wats.	CB/E and USS	Chrysomelidae and *Liriomyza* sp.	*Trichomalopsis* sp. (on chrysomeild)†
Plantanaceae			
Platanus racemosa Nutt.	LSBM	*Phyllonorycter felinelle* Heinrich	*Horismenus texanus* (Girault), *Chrysocharis walleyi* Yoshimoto, *Conura side* (Walker), *Closterocerus* sp., *Diglyphus begini* (Ashmead), *Sympiesis marylandensis* Girault†
Poaceae			
Elymus glaucus Buckley	CS/FDBM	*Elachista* sp.	*Pholetesor* n. sp. 5, *Bracon* sp.‡
Ehrharta erecta Lam.	CS/FDBM	*Elachista* sp.	*Colastes* sp., *Pholetesor bedelliae* (Viereck)‡
Hierochloe sp.	CS/FDBM	*Elachista* sp.	*Colastes* sp., *Pholetesor bedelliae* (Viereck)‡
bunchgrass	CS/FDBM	*Elachista* sp.	*Pholetesor bedelliae* (Viereck)‡
Rhamnaceae			
Ceanothus cuneatus (Hook.)	USS	*Stigmella* sp.	*Mirax ectodemiae* (Rohwer)‡
Ceanothus crassifolius Torr.	USS/FDBM	*Tischeria* sp.	*Chrysocharis* n. sp., *C. nephereus* (Walker), *Dolichogenidea tischeriae* (Viereck)†
Ceanothus greggii Gray	USS	*?Marmara* sp.	*Neochrysocharis diastatae* (Howard)†
Ceanothus greggii Gray	USS/FDBM	*?Tischeria* sp.	*Mesopolobus* sp., *Zagrammosoma mirum* Girault, *Z. americanum* Girault†
Ceanothus integerrimus H and A	CS/E	*Bucculatrix ceanothi* Braun	*Pholetesor bucculatricis* (Muesebeck)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Ceanothus integerrimus H and A	USS	*Stigmella* sp.	*Adelius* sp., *Guamptodon* sp.‡
Ceanothus integerrimus H and A	USS/FDBM	*Tischeria* sp.	*Apanteles* sp.‡
Ceanothus integerrimus H and A	CB		*Zagrammosoma americanum* Girault†
Ceanothus integerrimus H and A	USS	*Stigmella ceanothi* (Braun)	*Chrysocharis* sp.‡
Ceanothus leucodermis Greene	USS/FDBM	*Tischeria* sp. and *Recurvaria* sp.	*Cirrospilus coachellae* Gates, *Bassus cintus* (Cresson), *Elachertus cacoeciae* (Howard), *Chelonus* sp.†
Ceanothus thyrsiflorus Eschsch.	CS/E	*Bucculatrix ?ceanothi* Braun	*Pholetesor bucculatricis* (Muesebeck)‡
Ceanothus thyrsiflorus Eschsch.	USS/FDBM	*Tischeria* sp.	*Apanteles* sp.‡
Ceanothus velutinus Dougl.	USS/FDBM	*Tischeria* sp.	*Apanteles* sp.‡
Ceanothus sp.		*Acanthopteroctetes unifascia* (Davis)	*Mirax ectoedemiae* (Rohwer)†
Ceanothus sp.	USS/FDBM	*Tischeria ceanothi* Walsingham	*Colastes* sp., *Apanteles* sp.†
Ceanothus sp.	USS/FDBM	"leafminer"	*Apanteles* sp.‡
Ceanothus sp.	USS/FDBM	*Lyonetia ?prunifoliella* (Hübner)	*Pnigalio flavipes* (Ashmead), *Cirrospilus cinctithorax* (Girault)‡
Ceanothus sp.	USS		*Sympiesis stigmata* Girault†
Ceanothus sp.	USS	*Stigmella* sp.	*Parablastothrix nearctica* Miller, *Cirrospilus flavoviridis* Crawford‡
Ceanothus sp.	USS	*Stigmella ceanothi* (Braun)	*Chrysocharis* sp.‡
Ceanothus sp.	USS	*Stigmella inconspicuella* Newton and Wilkinson	*Chrysocharis* sp., *Ageniaspis bicoloripes* (Girault)‡
Ceanothus sp.	USS/FDBM	*Tischeria ceanothi* Braun	*Cirrospilus* sp.†
Rhamnus alnifolia L'Her.	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer)‡
Rhamnus californica Eschsch.	USS	*?Stigmella* sp.	*Mauleus nigritus* (Howard), *Chrysocharis walleyi* Yoshimoto, *Diglyphus* sp., *Neochrysocharis* sp., *Neochrysocharis diastatae* (Howard), *Closterocerus cincinnatus* Girault, *Ageniaspis bicoloripes* (Girault)†
Rhamnus californica Eschsch.	USS/B	*Phyllonorycter incanella* (Wlsm.)	*Neochrysocharis diastatae* Howard†
Rhamnus californica Eschsch.	USS	*Stigmella* sp.	*Cirrospilus* sp., *Chrysocharis* sp., *Chrysocharis clarkae* Yoshimoto, *Adelius* sp., *Colastes* sp., *Guamptodon* sp.‡
Rhamnus crocea Nutt.	CS/FDBM	*Apophthisis congregata* Braun	*Mirax* sp., *Mirax ectoedemiae* (Rohwer), *Gelis* sp. 2 (male), *Miotropis californicus* Girault‡
Rhamnus crocea Nutt.	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer), *Paradelius rubra* Whitfield‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Rhamnus rubra Greene	C/FDBM	*Apophthisis congregata* Braun	*Pnigalio flavipes* (Ashmead), *Sympiesis stigmata* Girault, *Adelius* sp., *Colastes* sp.‡
Rhamnus purshiana DC.	SSM	*Marmara* sp.	*Mirax ectoedemiae* (Rohwer)‡
Rosaceae			
Amelanchier alnifolia (Nutt.)	LSBM/LS	*Parornix ?alta* (Braun)	*Pholetesor salicifoliellae* (Mason), *Rhysipolis decorator* (Haliday), *Sympiesis* sp., *Elachertus cacoecia* (Howard)‡
Amelanchier alnifolia (Nutt.)	LSBM	*Phyllonorycter* sp.	*Sympiesis marylandensis* Girault‡
Cercocarpus betuloides Nutt.	CS/FDBM	*Coptodisca* sp.	*Mirax ectoedemiae* (Rohwer)‡
Cercocarpus betuloides Nutt.	SSM	*Marmara* sp.	*Mirax ectoedemiae* (Rohwer)‡
Cercocarpus betuloides Nutt.	USS	*Stigmella* sp.	*Apanteles* sp., *Chelonus*, sp., *Gelis* sp. 1 (fem)‡
Cercocarpus betuloides Nutt.	CS/FDBM	*Coptodisca cercocarpella* Braun	*Apanteles* prob. n. sp., *Neochrysocharis diastatae* (Howard), *Chrysocharis* sp.†
Cercocarpus ledifolius Nutt.	USS	*Stigmella* sp.	*Cirrospilus flavoviridis* Crawford, *Chelonus* sp., *Chrysocharis wahli* Hansson, *Apanteles* nr. *scutellaris* (Meus.)†
Cotoneaster sp.	LSBM	*Phyllonorycter mespilella* (Hübner)	*Chrysocharis walleyi* Yoshimoto‡
Crataegus douglasii Lindley	LSBM/LS	*Parornix* sp.	*Sympiesis* sp.‡
Crataegus sp.	LSBM	*Phyllonorycter mespilella* (Hübner)	*Pholetesor salicifoliellae* (Mason)
Fragaria vesca L.	USS/FDBM	*Tischeria* sp.	*Mirax ectoedemiae* (Rohwer)
Heteromeles arbutifolia (Lindley)	SSM	*Marmara* sp.	*Chelonus* sp., *Mirax ectoedemiae* (Rohwer)‡
Holodiscus discolor (Pursh.)	LSBM	*Phyllonorycter holodisci* (Braun)	*Sympiesis dolichogaster* (Ashmead)‡
Horkelia sp.	FDBM	*Scrobipalpula* sp.	*Dolichogenidea* sp.‡
Lyonothamnus floribundus A. Gray	USS	*Stigmella* n. sp.	*Mirax ectoedemiae* (Rohwer)‡
Prunus andersonii A. Gray	LSBM	*Parornix* sp.	*Apanteles* sp.‡
Prunus emarginata (Hook.)	LSBM/LS	*Caloptilia* sp.	*Pholetesor salicifoliellae* (Mason)‡
Prunus ilicifolia (Nutt.)	FDBM	*Paraleucoptera heinrichi* Jones	*Chelonus* sp., *Mirax ectoedemiae* (Rohwer), *Cirrospilus cinctithorax* (Girault), *Pnigalio flavipes* (Ashmead), *Scambus hirticauda* (Provancher), *Viridipyge prunicola* Whitfield‡
Prunus ilicifolia (Nutt.)	USS	*Stigmella* sp.	*Parablastothrix nearctica* Miller, *Chrysocharis* sp., *Cirrospilus flavoviridis* Crawford‡
Prunus ilicifolia (Nutt.)	USS or LSS	*Phyllocnistis* sp.	*Chrysocharis walleyi* Yoshimoto, *Pnigalio coloni* Girault, *Sympiesis* sp.‡
Prunus ilicifolia lyonii (Eastw.) Raven	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Prunus virginiana L.	LSBM/LS	*Parornix* sp.	*Sympiesis marylandensis* Girault, *Pholetesor salalicus* (Mason)‡
Prunus virginiana L.	LSBM/LS	?*Parornix* sp.	*Colastes* sp., *Pholetesor salicifoliellae* (Mason)‡
Prunus sp.	LSBM/LR	*Caloptilia invariabilis* Braun	*Sympiesis marylandensis* Girault, *Aprostocetus* sp.‡
Rosa sp.	USBM	*Ectoedemia* sp.	*Mirax ectoedemiae* (Rohwer)‡
Rubus parviflorus Nutt.	USS/FDBM	*Tischeria splendida* Braun	*Colastes* sp., *Mirax ectoedemiae* (Rohwer)‡
Rubus ursinus Cham. and Schldl.	SSM	*Marmara* sp.	*Mirax ectoedemiae* (Rohwer)‡
Rubus sp.	USBM	*Ectoedemia rubifoliella* (Clem.)	*Chrysocharis* sp.‡
Unidentified Rosaceae	LSBM	*Phyllonorycter mespilella* (Hübner)	*Sympiesis* sp.‡
Rubiaceae			
Cephalanthusoccidentalis Benth.	CS/FDBM	*Mompha cephalonthiella* (Cham.)	*Pnigalio flavipes* (Ashmead)‡
Rutaceae			
Citrus × *paradisi* MacFad.	Peelmine	*Marmara gulosa* Guillén and Davis	*Pnigalio coloni* (Girault), *Closterocerus utahensis* Ashmead, *Cirrospilus coachellae* Gates†
Citrus × *paradisi* MacFad.	LSS and USS/SSM	*Phyllocnistis citrella* Stainton	*Closterocerus utahensis* Crawford†
Salicaceae			
Populus freemontii Wats.	LSBM/LR	*Caloptilia palustriella* (Braun)	*Pholetesor salicifoliellae* (Mason)‡
Populus freemontii Wats.	FDBM	*Paraleucoptera albella* (Cham.)	*Pholetesor* n. sp. 4‡
Populus sp.	LSBM	*Phyllonorycter nipigon* (Freeman)	*Sympiesis ?marylandensis* Girault, *Zagrammosoma multilineatum* (Ashmead), *Sympiesis stigmata* Girault, *Zagrammosoma americanum* Girault, *Sympiesis sericeicornis* (Nees).
Populus sp.	LSBM	*Phyllonorycter* sp.	*Apanteles* sp.‡
Salix coulteri Anderss.	LSBM	*Phyllonorycter apicinigiella* (Clem.)	*Colastes* sp.‡
Salix laevigata Bebb	LSBM/LS	*Caloptilia palustriella* Braun	*Pnigalio levis* Yoshimoto‡
Salix lasiolepis Benth.	FDBM	*Paraleucoptera albella* (Cham.)	*Zagrammosoma americanum* Girault‡
Salix lasiolepis Benth.	USBM	blotch miner	*Bassus* sp.‡
Salix lasiolepis Benth.	USS	*Stigmella* sp.	*Mirax ectoedemiae* (Rohwer)‡
Salix sp.	USS/FDBM	*Coptodisca saliciella* (Clem.)	*Colastes* sp.‡
Salix sp.	LSBM/FDBM	*Micrurapteryx salicifoliella* (Cham.)	*Pholetesor salalicus* (Mason)‡
Salix sp.	LSBM	*Phyllonorycter* sp.	*Pholetesor salicifoliellae* (Mason)‡
Salix sp.	LSBM	*Phyllonorycter deserticola* Davis and Desc.	*Sympiesis marylandensis* Girault, *Pnigalio flavipes* (Ashmead), *Pnigalio* sp.‡
Salix sp.	LSBM	*Phyllonorycter crugatus* Davis and Desc.	*Sympiesis marylandensis* Girault, *Sympiesis sericeicornis* (Nees)‡

Table 1. Continued.

Plant family/species	Guild	Leafminer	Parasitoids
Salix sp.	LSBM	*Phyllonorycter salicifoliella* (Clem.)	*Sympiesis sericeicornis* (Nees), *Sympiesis marylandensis* Girault, *Chrysocharis* spp. *Chrysocharis boriquensis* Hansson, *Achrysocharoides ?zwoelferi* (Delucchi), *Cirrospilus cinctithorax* (Girault), *Diglyphus pulchripes* (Crawford), *Aprostocetus* sp.‡
Salix sp.	LSBM	*Phyllonorycter scudderella* (F and B)	*Sympiesis* sp.‡
Salix sp.	LSBM/LS	*Caloptilia palustriella* Braun	*Sympiesis marylandensis* Girault, *Sympiesis bimaculatipennis* Girault, *Cirrospilus flavicinctus* Riley, *Sympiesis sericeicornis* (Nees), *Pholetesor salalicus* (Mason)‡
Salix sp.	LSBM/LS	*Caloptilia* sp. (coastal)	*Sympiesis marylandensis* Girault‡
Salix and Populus	FDBM	*Coptodisca saliciella* (Clem.)	*Cirrospilus* sp.‡
Sapindaceae			
Acer macrophyllum Pursh	LSBM/LS	*Caloptilia* sp.	*Sympiesis marylandensis* Girault, *Ageniaspis bicoloripes* (Girault), *Chelonus* sp., *Pholetesor salicifoliellae* (Mason), *Rhysipolis decorator* (Hal.), *Diaglyptidea* sp., *Scambus hirticauda* (Provancher)‡
Acer negundo L.	LSBM/LS	*Caloptilia negundella* (Cham.)	*Pholetesor bedelliae* (Viereck)‡
Scrophulariaceae			
Keckiella cordifolia (Benth.)	CB		*Pnigalio coloni* (Girault)†
Penstemon caesius A. Gray	CS		*Chrysocharis ainsliei* Crawford, *Eurytoma* sp., *Callimerismus* ?n. sp., *Thinodytes petiolatus* Heydon†
Solanaceae			
Lycium cooperi Gray	LTM	?Gelechiinae	*Apanteles* nr. *scutellaris* (Mues.), *Habrobracon* sp.†
Lycopersicon esculentum Mill.	USS	Agromyzidae	*?Closterocerus* sp.†
Nicotiana glauca Grah.	SSM	*Marmara* n. sp.	*Cirrospilus coachellae* Gates†
Thymelaeaceae			
Dirca occidentalis A. Gray	USBM	*Leucanthiza dircella* Braun	*Colastes* sp.‡
Tropaleaceae			
Tropaeum nasturtium L.	CS	*Liriomyza* ?sp.	*Diglyphus begini* (Ashmead)†
Ulmaceae			
Ulmus sp.	USBM	*Cameraria ulmella* (Cham.)	*Ageniaspis bicoloripes* (Girault), *Sympiesis* sp.‡
Verbenaceae			
Lantana camara L.	USBM	*Liriomyza* sp.	*Diglyphus begini* (Ashmead), *Halticoptera* sp., *Baryscapus* sp., *Closterocerus* sp.†

Table 1. Continued.

Plant family, species	Guild	Leafminer	Parasitoids
Vitaceae			
Vitis californica Benth.	USS	?*Phyllocnistis* sp.	*Chrysocharis walleyi* Yoshimoto, *Pnigalio levis* Yoshimoto, *Zagrammosoma* sp., *Hormius* sp., *Neochrysocharis arizonensis* (Crawford), *Cirrospilus cinctithorax* (Girault), *Cirrospilus* sp.†
Miscellany—plant unknown			
??	USS/FDBM	*Tischeria* sp.	*Zagrammosoma mirum* Girault‡

Leafmine Guild abbreviations are as follows: CB = complete blotch, CS = complete serpentine, CB/E = complete blotch with internal/external feeding, CS/E = complete serpentine then external, LR = leaf roll, LS = leaf shelter, LSBM = lower surface blotch, LSS = lower surface serpentine, LTM = leaf(-ves) tied/mined, MVT = mines vascular tissue, SSM = stem serpentine USS = upper surface serpentine, USS/FDBM = upper surface, full depth blotch mine, USBM = upper surface blotch, ≫ = guild on left side of ≫ becomes the guild on the right side of the ≫.

† Indicates parasitoids reared from individual leafmines.

‡ Indicates parasitoids lot-reared from >1 leafmines from a single plant.

suspended ceilings. This enabled rapid viewing of multiple vials simultaneously rather than examining each vial separately. Once processed, samples were placed into rectangular Rubbermaid™ tubs containing saturated salt solution which maintained relative humidity at ~75% (Winston and Bates 1960). Samples were examined daily, and any emergence recorded. Rearing success was approximately 18%. Parasitoids and leafmining Agromyzidae were killed with 70% ethanol and prepared for mounting using hexamethyldisilizane (HMDS) dehydration (Heraty and Hawks 1998). Leafmining Lepidoptera were prepared according to Landry and Landry (1994).

Protocols of DLW and JBW presented in Whitfield and Wagner (1988) are reiterated here. The DLW and JBW plant material collected in the field was sorted by plant and miner species, and subsequently isolated by plant/miner lot in clear polyethylene bags lined with paper toweling (which often provided a pupation substrate for both the miners and their parasitoids). Most smaller lots were reared in 15–40 dram plastic vials (Wagner, pers. comm.). For overwintering generations, leaves or leaf portions with mines were placed in plastic snap-top vials and held for at least 6 weeks in a refrigerator or freezer to break diapause, before removal from cold for adult emergence. No success rates on a per leaf mine basis are possible given that much of the samples were bulk reared. Plant identifications were mostly supplied by the collectors; some difficult determinations were made by the herbarium staff of the University of California, Berkeley. Adult leafminers and mines were identified by DLW, with some additional identifications supplied by JBW and by J. A. Powell and J. A. DeBenendictis of the University of California at Berkeley.

Illustrations in this paper provide representation of the features diagnostic of a particular taxon even though they may not be derived from actual specimens recovered in this study. Many of the line illustrations are taken with permission from the following sources: Goulet and Huber 1995, Townes 1970a, b, Gibson et al. 1997, Schauff et al. 1998. Diagnoses are modified from Schauff et al. (1998) and the references provided therein are for known works on a particular taxon worldwide.

Taxa known to attack CLM have been recorded previously (Schauff et al. 1998). Other genera attacking leafminers not treated herein, particularly within Chalcidoidea, most likely remain to be discovered with continued rearing of Californian leafminers. Readers are referred to keys in Gibson et al. (1997) for keys to Nearctic Chalcidoidea, to Whitfield and Wagner (1991) for Braconidae, and Townes (1970a, b) for Ichneumonidae.

New host/parasitoid associations for Chalcidoidea only, based upon comparison with records found in Noyes (1998), are indicated by an asterisk in Table 2. Distributional notes appearing after the diagnosis of each genus are taken primarily from Krombein et al. (1979), Noyes (1998) and Gibson et al. (1997). Only Chalcidoidea are treated in Table 2 as there exists no definitive work analogous to the Noyes CD-ROM that treats any of the non-Chalcidoidea taxa documented herein. However, as Noyes (1998) is only a compilation of the literature pertaining to Chalcidoidea, information therein is only as reliable as its original source. Although many parasitoids included here were reared from a single leafmine (indicated with + (Table 1)), other parasitoids issued from bulk rearing of numerous leafmines from a single plant host in a single bag (indicated with ++ (Table 1)). The labeling scheme (+,++) used in Table 1 provides an indication as to the relative degree of definitiveness of a particular host/parasitoid interaction. Those records with a single + should be regarded as probable associations since all mines were reared individually. A [?] preceding a taxon name in Table 1 indicates that the taxon is tentatively identified, typically due to specimen collapse or other damage obscuring diagnostic characters. Those taxa are identified to genus in all but 6 instances where only subfamily identification is possible. All specimens from MWG/JMH rearings are deposited at UCRC and those of DLW and JBW are in the collections of University of Connecticut and University of Illinois, respectively. The Ichneumonidae identified by David Wahl are deposited in AEIC.

Morphological terms are indicated on several figures (Figs. 1–10, 12–17, 19–21, 28, 31–32, 35, 55, 60–61, 63, 66–68, 72–73, 78, 79, 81, 84–85, 87, 89, 102–103, 106, 108–109, 114–115, 117) and not discussed in detail. Gastral tergum is abbreviated as Gtn where n = gastral tergite number. Further discussion of morphology of Hymenoptera in general and Chalcidoidea in particular can be found in Goulet and Huber (1995) and Gibson et al. (1997), respectively.

Acronyms are: UCRC = University of California Collection, Riverside, CA; AEIC = American Entomological Institute Collection, Gainesville, Florida.

KEY TO FAMILIES AND GENERA OF CALIFORNIA LEAFMINER PARASITOIDS

1 Apterous. Antenna with more than 13 flagellomeres (Fig. 13). Ovipositor prominently exserted, 1.0–1.3× as long as length of hind femur. Trochantellus present (trochanter appearing two-segmented (Fig. 13)) .... 1 .... ***Gelis*** (ICHNEUMONIDAE: CRYPTINAE)

1′ Macropterous. Antenna with ≤13 flagellomeres (or, if >13 flagellomeres, then macropterous (Braconidae)). Ovipositor sometimes exserted and as long as or longer than length of hind femur. Trochantellus present or absent (trochanter appearing one- or two-segmented) 2

2 Fore wing venation complete, with at least 2 closed cells (Figs. 5, 7, 19–20). CHRYSIDOIDEA, ICHNEUMONOIDEA 3

2′ Fore wing venation reduced, with fewer than 2 closed cells (Fig. 45). CHALCIDOIDEA 12

3 Abdominal sterna as strongly sclerotized as terga; head prognathous; pronotum shaped

like truncated pyramid in dorsal view (Fig. 23); clypeus with median longitudinal carina (Fig. 23). CHRYSIDOIDEA: BETHYLIDAE ..... 9. *Goniozus*

3′ Abdominal sterna less strongly sclerotized than terga; head usually hypognathous (Figs. 10–15); pronotum transverse to subquadrate in dorsal view; clypeus lacking median longitudinal carina. ICHNEUMONOIDEA 4

4 Fore wing with vein 1/Rs+M separating cells 1M and 1R1 (Fig. 7); hind wing with vein 1r-m basal to separation of veins R1 and Rs (Figs. 3, 9); metasomal terga 2+3 fused with inflexible junction (Fig. 11). BRACONIDAE ..... See pg. 248

4′ Fore wing without vein 1/Rs+M, with compound cell 1M+1R1 present (Fig. 5); hind wing with vein 1r-m opposite or apical to separation of veins R1 and Rs (Figs. 1–2); metasomal tergum 2 usually separate from tergum 3, with flexible junction (Fig. 10). ICHNEUMONIDAE 5

5 Fore wing cell 1+2Rs (=areolet) large and rhombic (diamond-shaped) (Figs. 5, 14). Ovipositor long and needle-like, ovipositor sheath long and rigid. Male genitalia with gonoforceps produced into elongate process (Fig. 16). Upper margin of supraclypeal area with transverse carina below antennal sockets ..... 2. *Mesochorus* (MESOCHORINAE)

5′ Fore wing cell 1+2Rs obliquely quadrate, pentagonal, or open (vein 3r-m absent) (Figs. 12, 15). Ovipositor stouter, ovipositor sheath sometimes curved. Male genitalia with gonoforceps not produced into elongate process. Upper margin of supraclypeal area without transverse carina below antennal sockets 6

6 Metasomal segment 1 in dorsal view with apex about as wide as base. Tergite 1 with glymma present at base of tergite (Fig. 10) 7

6′ Metasomal segment 1 petiolate in dorsal view, apex 1.8–3.3× as wide as base. Tergite 1 with glymma absent 8

7 Pleural sulcus (=mesopleural suture) without distinct angulation opposite scrobe (Fig. 15). Hind wing with vein 2-cu meeting vein cu-a distinctly closer to vein M than vein 1A (Fig. 15). Hind tibia fuscous with median pale band, apex thus being dark ..... 3. *Pimpla* (PIMPLINAE)

7′ Pleural sulcus with distinct angulation opposite scrobe (Fig. 8). Hind wing with vein 2-cu meeting vein cu-a more or less equidistant between veins M and 1A (Fig. 18). Hind tibia with apical and subapical dark bands, extreme base thus being pale ..... 4. *Scambus* (PIMPLINAE)

8 Propleuron with ventroposterior corner having strongly produced, more or less angulate lobe touching or overlapping pronotum (cf. Fig. 26). Mesothorax ventrally with postpectal carina complete (Fig. 4). Mesopleuron with sternaulus short, about 0.3× as long as mesopleuron (Fig. 17) ..... 5. *Campoplex* (CAMPOPLEGINAE)

8′ Propleuron with ventroposterior corner not produced as distinct lobe, not angulate, at most with weak groove delimiting it from main area of propleuron (cf. Fig. 27). Mesothorax ventrally with postpectal carina interrupted in front of each middle coxa or completely absent. Mesopleuron with sternaulus extending to middle coxa or nearly so 9

9 Outer face of mandible with sub-basal swelling, at extreme base with transverse groove that emphasizes swelling. Lateral face of pronotum with epomia absent and surface granulate ..... 1. *Gelis* (CRYPTINAE)

9′ Outer face of mandible without sub-basal swelling. Lateral face of pronotum with epomia present (Fig. 6) and surface polished and rugulose 10

10 Notaulus long and sharp, ending beyond middle of mesoscutum (Fig. 50). Apex of clypeus with two median denticles ..... 8. *Bathythrix* (CRYPTINAE)

10′ Notaulus not reaching middle of mesoscutum. Apex of clypeus without denticles 11

11 Apical 0.3 of clypeus strongly inflexed and covered with brush of long setae ..... 6. *Diaglyptidea* (CRYPTINAE)

11′ Clypeus uniformly convex and without brush of long setae .. 7. *Encrateola* (CRYPTINAE)

12 Tarsi 5 segmented, protibial spur curved apically and bifid (Fig. 24). Funicle with 5 or more segments (Figs. 32, 35) 13

12′ Tarsi 4 segmented, protibial spur straight and simple (Fig. 25). Funicle with 2–4 segments (Figs. 28, 30, 31, 33, 38–39) EULOPHIDAE 31
13 Mesopleuron swollen, convex, glabrous, longer than high (Figs. 61, 63) 14
13′ Mesopleuron not swollen, concave, variously sculptured, shorter than high (Figs. 51–52) 16
14 Mesocoxa inserted at or anterior to midline of mesopleuron (Fig. 61). Cercus usually advanced (Fig. 61). Marginal vein usually shorter than stigmal vein (Figs. 29, 42) ENCYRTIDAE 15
14′ Mesocoxa inserted posterior to midline of mesopleuron (Fig. 63). Cercus never advanced, placed at apex of metasoma (Fig. 66). Marginal vein usually longer than stigmal vein (as in Figs. 41, 44). EUPELMIDAE (females) 20
15 Scutellum with deep longitudinal striate sculpture contrasting with shallow reticulate sculpture on mesoscutum. Clava 1-segmented (Fig. 35). PMV at least 1.5× as long as stigmal vein (Fig. 42). Eye not approaching mouth margin, malar space >¼ eye length. Male with all funiculars unbranched ..... 10. *Ageniaspis*
15′ Scutellum lacking striate sculpture, with reticulate sculpture similar to mesoscutum. Clava 3-segmented. PMV <1.5× as long as stigmal vein (Fig. 29). Eye nearly reaching mouth margin, malar space <¼ eye length (Fig. 60). Male with first four funiculars branched (as in Fig. 33) ..... 11. *Parablastothrix*
16 Hind femur enlarged, <3× as long as broad, dentate ventrally (Fig. 103). Axillar and parascutal carinae converging directly above wing base in arch-like fashion (Fig. 102). CHALCIDIDAE 17
16′ Hind femur not enlarged, >3× as long as broad, smooth ventrally (as in Figs. 36–37). Axillar and parascutal carinae converging on dorsum mesad of wing base in V-like fashion (as in Fig. 81) 18
17 Gaster petiolate, petiole subquadrate to very long (Fig. 107); propodeum with spiracle subvertical or nearly longitudinal ..... 12. *Conura*
17′ Gaster sessile, petiole at most visible as transverse line (Fig. 102); propodeum with spiracle mostly diagonal (Fig. 104) ..... 13. *Brachymeria*
18 Pronotum quadrate in dorsal view (Fig. 106). Head and dorsum with umbilicate sculpture (Fig. 106). Body usually non-metallic (black, yellow, brown). EURYTOMIDAE ..... 34. *Eurytoma*
18′ Pronotum transverse in dorsal view (as in Figs. 62, 64, 84). Head and dorsum lacking umbilicate sculpture, usually reticulate (as in Figs. 64, 79, 101). Body usually metallic (green, blue) 19
19 Pronotum in dorsal view narrowed medially (Fig. 64). Notauli absent (Fig. 64). Protibia with dorsoapical spicules (Fig. 65) EUPELMIDAE (males) 20
19′ Pronotum in dorsal view not narrowed medially (Fig. 118). Notauli at least visible anteriorly on mesoscutum, often complete (Fig. 79). Protibia lacking dorsoapical spicules .. 21
20 Metasoma with posterior margin of syntergum deeply, subcircularly emarginate, the emargination often surrounding a sclerotized horizontal to vertical anal sclerite (Fig. 68); mesotibia lacking apical groove between tibial spur and base of tarsus (Fig. 69); metasoma with penultimate tergum medially divided or with median hyaline line **and** largely or entirely concealed under preceding tergum ..... 32. *Eupelmus*
20′ Metasoma with posterior margin of syntergum truncate or variously differentiated into a rim or fingernail-like flange (Fig. 66); mesotibia almost always with apical groove between tibial spur and base of tarsus (Fig. 67); metasoma with penultimate tergum neither divided nor largely or entirely concealed under preceding tergum ..... 33. *Brasema*
21 Head with occipital carina (may be fine) (Figs. 48–49). Metacoxa usually subtriangular in cross section and broadly attached to mesosoma (Figs. 51–52). Fore wing usually with marginal vein long and stigmal vein short (Figs. 40–41). TORYMIDAE 22
21′ Head without occipital carina, or if with carina then metacoxa usually subcircular in cross

section and narrowly attached to mesosoma. Fore wing venation different than above (Figs. 44, 46, 55). PTEROMALIDAE 23

22 Metapleuron separated by a straight line from mesopleuron, not projecting anteriorly (Fig. 51). Metafemur convex ventrally, sometimes serrate (Fig. 46). Marginal vein at most 5 times as long as stigmal vein and more than 3 times as long as postmarginal vein (as in Fig. 41) ..... 43. ***Microdontomerus***

22′ Metapleuron separated by a sinuous line from mesopleuron, projecting anteriorly (Fig. 52). Metafemur not convex ventrally, sometimes serrate (as in Fig. 36). Marginal vein at most 5 times as long as stigmal vein and more than 3 times as long as postmarginal vein (as in Fig. 40) ..... 44. ***Torymus***

23 Clypeal margin at least slightly asymmetric, with 2 or 3 teeth separated by at least one deep incision (Figs. 73, 82). MISCOGASTERINAE 24

23′ Clypeal margin usually symmetric and without deep incision, at most with shallow emargination (Figs. 78, 83, 112). PTEROMALINAE, SPALANGIINAE 27

24 Propodeum strongly sculptured, reticulate to rugose, submedially (as in Fig. 80). Clypeal margin with 3 asymmetric teeth ..... 35. ***Callimerismus***

24′ Propodeum glabrous to moderately reticulate (Figs. 72, 76) or with two convergent submedian lines of punctures (Fig. 113). Clypeal margin usually with 2–3 more or less asymmetric teeth or entire and produced (Figs. 78, 82, 112) 25

25 Clypeal margin either with one asymmetrical tooth (Fig. 75) or with 3 teeth, but then teeth usually sharp and with only a narrow gap between them ..... 36. ***Thinodytes***

25′ Clypeal margin usually with two distinct teeth having broad gap between them (Figs. 73, 82) 26

26 Torulus at or below lower eye margin. Petiole usually with median carina and with anterolateral corners not enlarged (Fig. 74). *Males*: palpus and/or stipes more or less enlarged, yellow (Fig. 73) ..... 37. ***Halticoptera***

26′ Torulus above lower eye margin. Petiole usually without median carina and with anterolateral corners sharp and enlarged (as in Fig. 77). *Males*: palpus and/or stipes slender, dark ..... 38. ***Maulens***

27 Toruli at extreme lower margin of head (Fig. 112). Head almost prognathous. Flagellum lacking anellus and with 7 funiculars. SPALANGIINAE ..... 42. ***Spalangia***

27′ Toruli never so low on face, typically closer to middle (Figs. 78, 81). Head hypognathous. Flagellum with 1–3 anelli (Fig. 32). PTEROMALINAE 28

28 Antenna with 2 anelli and 6 funicular segments (Fig. 32). Occiput with fine to strong arched margin or fold (as in Fig. 49) ..... 39. ***Trichomalopsis***

28′ Antenna with 3 anelli and five funicular segments. Occiput lacking margin or fold 29

29 Pronotal collar with an abruptly angled or rounded margin (Fig. 81). Head moderate in dorsal view, >2.0× as long as broad. Gena curved to more angulate (Fig. 78). Hypopygium >0.5× the length of gaster ..... 40. ***Mesopolobus***

29′ Pronotal collar less abruptly angled, often only margined medially (Fig. 70). Head stout in dorsal view, <2.0× as long as broad. Gena moderately curved and converging in anterior view (Fig. 56). Hypopygium <0.5× the length of gaster ..... 41. ***Pteromalus***

30 Scutellum with 2 pairs of setae (Fig. 91), rarely more. Submarginal vein with 1 or more setae dorsally (as in Figs. 45, 57). Head with transverse fronto-facial suture, if present, adjacent to anterior ocellus (Fig. 110). Notauli present or absent (Figs. 99, 114). EULOPHIDAE: Eulophinae, Tetrastichinae, Euderinae 31

30′ Scutellum with 1 pair of setae (Figs. 84–87). Submarginal vein with 2 setae dorsally (Figs. 53–54, 59). Head with transverse fronto-facial suture, if present, separated from anterior ocellus by distance greater than diameter of ocellus (Fig. 89). Notauli usually absent (Fig. 87). EULOPHIDAE: Entedoninae 34

31 Notauli present and either reaching posterior margin of mesoscutum or curving to meet axillae (Figs. 108, 114) 32

31′ Notauli absent or incomplete posteriorly and not approaching posterior margin of mesoscutum or axillae (Figs. 87–88, 95, 111) 33
32 Fore wing posteriad of marginal vein usually with bare area except for distinct row of admarginal setae on ventral surface (Fig. 45), and usually with 2–3 rows of setae radiating from stigmal vein (Fig. 45). EUDERINAE ..... 31. *Euderus*
32′ Fore wing different, if with bare area posteriad of marginal vein, then lacking such distinctive rows of radiating setae (Fig. 54) 33
33 Postmarginal vein reduced or absent, less than ⅓ length of stigmal vein (Fig. 57). Scutellum with paired submedial grooves, often with sublateral grooves, grooves never convergent apically (Figs. 91, 93). Notaulus always complete, axilla strongly advanced, scapula linear. Funicular segments: female with 3 and male with 4. TETRASTICHINAE ... 40
33′ Postmarginal vein present, at least ½ length of stigmal vein (Figs. 54, 59). Scutellum lacking paired submedial grooves **and** sublateral grooves, at most with single pair of submedian grooves which are or are not convergent apically (Figs. 95, 97–100). Notaulus complete or incomplete, when complete then axilla either not or only slightly advanced, scapula triangular. Funicular segments never in above combination. EULOPHINAE ... 41
34 Propodeum with shiny medial strip, bordered laterally by depressed and usually sculptured area, area laterad of depressed area usually also shiny (Fig. 85). Scutellum with median longitudinal groove running almost entire length (Fig. 84). ENTEDONINAE ... . 25. *Horismenus*
34′ Propodeum not as above, with or without median carina, but never with shiny median strip. Scutellum generally without median longitudinal groove 35
35 Propodeum with distinct plica, and with paired median carina which diverge posteriorly (Fig. 86). Pronotum with a transverse carina on anterior edge ..... 26. *Pediobius*
35′ Propodeum without plica, without median carina which diverge posteriorly. Pronotum with or without a transverse carina on anterior edge 37
37 Postmarginal vein elongate, at least 1.5× as long as stigmal vein (Fig. 53) .... 27. *Chrysocharis*
37′ Postmarginal vein shorter, at most as long as stigmal vein (Figs. 54, 59) 38
38 Frontofacial groove transverse, straight, slightly raised (Fig. 89). Eye pilose. Postmarginal vein about equal in length to stigmal vein (as in Fig. 59). Mesoscutum and/or scutellum often with pits (Fig. 88) ..... 28. *Achrysocharoides*
38′ Frontofacial grooves present as V- or Y-shaped sutures (Fig. 110). Other characters variable, never present in above combination 39
39 Fore wing lacking line of setae extending distally from stigmal vein (Fig. 59), never with infuscate transverse bands (Fig. 59). Transepimeral suture distinctly curved (Fig. 115) .. .. 29. *Neochrysocharis*
39′ Fore wing with single line of setae extending distally from stigmal vein (Fig. 54), sometimes with infuscate transverse bands (Fig. 54). Transepimeral suture straight or only slightly curved (Fig. 117) ..... 30. *Closterocerus*
40 Propodeal callus with raised lobe overhanging outer rim of spiracle (Fig. 91). Cercal setae unequal in length, one distinctly longer than others and sinuate (Fig. 92) 24. *Aprostocetus*
40′ Propodeal callus without raised lobe overhanging rim of spiracle (Fig. 93). Cercal setae equal in length, the two longest being subequal and straight or only slightly curved (Fig. 94) ..... 23. *Baryscapus*
41 Funicle 2 segmented (Fig. 28) 42
41′ Funicle 3 or 4 segmented (Figs. 30–31, 38–39) 45
42 Scutellum with submedian grooves (Fig. 95). Notauli incomplete (Fig. 95) ... 14. *Diglyphus*
42′ Scutellum without submedian grooves. Notauli complete (Fig. 114) 43
43 Notauli curving to meet anterior portion of axilla (Fig. 108). Axilla more or less advanced anteriorly beyond transscutal articulation (Fig. 108). Color yellow and black, never metallic and fore wing often with infuscate areas ..... 16. *Zagrammosoma*
43′ Notauli straight, extending to anterior portion of scutellum (Fig. 114). Axilla not greatly

advanced beyond transscutal articulation (Fig. 114). Body color variable, wing rarely infuscate 44

44 Postmarginal vein about 2× as long as stigmal vein. *Male*: scape enlarged (Fig. 28). Scutellum without submedian grooves. Color brown ..... 17. ***Diaulinopsis***

44′ Postmarginal vein equal to or shorter than stigmal vein (Fig. 58). *Male*: scape rarely enlarged. Scutellum with submedian grooves, though may be difficult to see due to changes in color pattern. Color variable, but often with extensive yellow markings .. 15. ***Cirrospilus***

45 Notauli incomplete; male funicle often with long branches (Fig. 33) 46

45′ Notauli complete, sometimes fine; male funicle often without or rarely with long branches 47

46 Propodeum with complete plica and a transverse costula extending from each plica to median carina (Fig. 98), the area between glabrous ..... 18. ***Puigalio***

46′ Propodeum without costula and usually without plica (Fig. 99), but if plicae present then area between distinctly reticulate 48

47 Torulus high on head, above lower eye margin, thus apex of scape extends beyond level of vertex (Fig. 90). Fore wing and costal cell narrow, fore wing at least 2.6× as long as broad and costal cell 10–15× as long as broad ..... 20. ***Hemiptarsenus***

47′ Torulus at or below lower eye margin, thus apex of scape not extending beyond level of vertex. Fore wing and costal cell not so narrow, fore wing less than 2.6× as long as broad and costal cell less than 10× as long as broad ..... 19. ***Sympiesis***

48 Scutellum with submedian grooves complete, curving medially at posterior margin and meeting or nearly meeting each other (Fig. 100) ..... 21. ***Elachertus***

48′ Scutellum with submedian grooves incomplete or absent, but if present then grooves usually straight, not curving or curving slightly mesad at posterior margin of scutellum (Fig. 96) ..... 22. ***Miotropis***

Superfamily Ichneumonoidea
Family ICHNEUMONIDAE
Subfamily Cryptinae

1. Genus *Gelis* Thunberg
(Fig. 13)

Diagnosis.—Females are apterous, with either apterous, brachypterous, or macropterous males; sometimes both sexes are macropterous. Mandible with strong subbasal swelling, at extreme base with transverse groove that emphasizes swelling. Clypeus weakly convex and without brush of long setae; apex often with weak median denticles. Center of pronotum without median longitudinal carina; lateral face without epomia. Mesoscutum with notaulus not reaching middle; surface matte. Cell 1+2Rs of fore wing often open.

Notes.—This genus is represented by at least 80 species in the Nearctic region and 10 species in California (Carlson 1979). Members of this genus are attack small cocoons of Lepidoptera, Neuroptera and other Ichneumonoidea, usually as a hyperparasitoid but occasionally as a primary parasitoid of small Lepidoptera. Other species parasitize eggs sacs of Araneae.

Subfamily Mesochorinae

2. Genus *Mesochorus* Gravenhorst
(Figs. 14, 16)

Diagnosis.—Upper margin of supraclypeal area with transverse carina below antennal sockets. Cell 1+2Rs of fore wing large and rhombic (diamond-shaped). Vein 2-Cu of hind wing. Glymmae of tergite 1 large and deep, almost meeting at midpoint. Ovipositor long and needlelike; ovipositor sheath long and rigid. Male genitalia with gonoforceps produced into elongate process.

Notes.—This large genus is worldwide in distribution, with 106 described species in the Nearctic; 22 of these occur in Cali-

Table 2. List of reared chalcidoid species and their leafmining hosts.

Parasitoid species	Host species*
Achrysocharoides ?laticollaris Kamijo	Unknown
Achrysocharoides villosus Kamijo	*Phyllonorycter* sp. (*Quercus chrysolepis* Leibm.)*[1]
Achrysocharoides ?zwoelferi	*Cameraria jacintoensis* Opler and Davis*
	Cameraria nemoris (Wlsm.)*
	Liriomyza sativae Blanchard*
	Phyllonorycter arbutusella Braun*
	Phyllonorycter ledella Wlsm.*
	Phyllonorycter ribefoliae (Braun)*
	Phyllonorycter salicifoliella (Clem.)*
	Phyllonorycter sp.[1] (*Q. chrysolepis*)
Aprostocetus sp.	*Caloptilia invariabilis* Braun*
	Cameraria agrifoliella (Braun)*
	Cameraria jacintoensis Opler and Davis*
	Cremastobombycia grindeliella Wlsm.*
	Phyllonorycter salicifoliella (Clem.)*
	Proleucoptera smilaciella (Bsk.)*
	Tischeria omissa Braun*
	Tischeria sp. (*Aster* sp., *Quercus alvordiana* Eastw.)
Baryscapus sp.	*Stilbosis dulcedo* Hodges*
	Tischeria pruinosella Cham.*
	Liriomyza sp. (*Lantana camara* L.)
Brachymeria sp.	Unknown lepidopteran
Brasema ?macrocarpae (Ashmead)	*Liriomyza* sp.* (*Datisca glomerata* (Presl.))
Chrysocharis ainslici Crawford	*Coelopocta glutinosi* (Wlsm.)*
	Phyllonorycter ribefoliae (Braun)*
	Calcomyza enceliae Spencer*
	Calcomyza sp.* (*Xanthium strumarium* L.)
	Chromatomyia syngenesiae Hardy
Chrysocharis boriquensis Hansson	*Phyllonorycter salicifoliella* (Clem.)*
Chrysocharis ?clarkae Yoshimoto	*Stigmella* sp.* (*Rhamnus californica* Eschsch.)
Chrysocharis oscinidis Ashmead	*Liriomyza* sp. (*Datisca glomerata* (Presl.))
Chrysocharis nephereus (Walker)	*Tischeria* sp. (*Ceanothus crassifolius* Torr.)
Chrysocharis wahli Hansson	*Stigmella* sp. (*Cercocarpus ledifolius* Nutt.)
Chrysocharis walleyi Yoshimoto	*Phyllocnistis* sp.* (*Prunus ilicifolia* (Nutt.))
	?Phyllocnistis sp.* (*Vitis californica* Benth.)
	Phyllonorycter fellinella Heinrich*
	Phyllonorycter mespilella (Hübner)
	?Stigmella sp.* (*Rhamnus californica* Eschsch.)
Chrysocharis n. sp.	*Coptodisca powellella* Opler
	Tischeria sp. (*Ceanothus crassifolius* Torr.)
Cirrospilus cinctithorax Girault	*Cameraria* nr *temblorensis* Opler and Davis*
	Lyonetia ?prunifoliella (Hübner)*
	Paraleucoptera heinrichi Jones*
	?Phyllocnistis sp. (*Vitis californica* Benth.)
	Phyllonorycter salicifoliella (Clem.)
Cirrospilus coachellae Gates	*Marmara gulosa* Guillén and Davis
	Marmara n. sp. (*Nicotiana glauca* Grah.)
	Tischeria sp.* (*Ceanothus leucodermis* Greene)
Cirrospilus flavoviridis Crawford	*Cameraria sempervirensella* Opler and Davis*
	Stigmella sp.* (*Ceanothus* sp., *Cercocarpus ledifolius* Nutt., *Prunus ilicifolia* (Nutt.))
	Cameraria n. sp.* (*Quercus vaccinifolia* Kellogg)
Cirrospilus flavicintus Riley	*Caloptilia palustriella* Braun*
	Neurobathra bohartiella Opler*

Table 2. Continued.

Parasitoid species	Host species*
Closterocerus utahensis Crawford	*Coelopocta glutinosi* (Wlsm.)*
	Liriomyza sativae Blanchard
	Liriomyza sp. (*Bidens pilosa* L.)
	Marmara gulosa Guillén and Davis*
	Phyllocnistis citrella Stainton*
	?Phytomyza sp. (*Eriodictyon crassifolius* Benth.)
	Stigmella rhoifoliella (Braun)*
Closterocerus cinctipennis Ashmead	*Coelopocta glutinosi* (Wlsm.)*
	Marmara gulosa Guillen and Davis*
	Tischeria arizonica Braun*
Closterocerus ?submutica Graham	*Liriomyza* sp. (*Cirsium vulgare* (Savi))
Closterocerus trifasciatus Westwood	*Lyonetia latistrigella* Wlsm.*
	Tischeria purinosella Cham.*
Conura side (Walker)	*Coelopocta glutinosi* (Wlsm.)*
	Phyllonorycter felinelle Heinrich*
	Tischeria sp. (*Quercus alvordiana* Eastw.)
Conura sp.	*Coelopocta* n. sp.* (*Phacelia* sp.)
	Tischeria discreta Braun*
	?Tischeria sp. (*Malacothamnus* sp.)
Diaulinopsis callichroma Crawford	*Liriomyza sativae* Blanchard*
Diglyphus begini (Ashmead)	*Liriomyza* spp. (*Salvia mellifera* Greene, *Tropaleum nasturtium* L., *Lantana camara* L., *Bidens pilosa* L., *Silybum marianum* Gaertn., *Hirschfeldia incana* (L.))
	Chromatomyia syngenesiae Hardy
	Coelopocta glutinosi (Wlsm.)*
	Phyllonorycter felinelle Heinrich*
Diglyphus pulchripes (Crawford)	*Phyllonorycter salicifoliella* (Clem.)
Elachertus cacoecia (Howard)	*Cameraria* sp.* (*Quercus turbinella* Greene)
	Parornix ?alta (Braun)*
	Tischeria sp.* (*Ceanothus leucodermis* Greene)
Euderus sp.	*Neurobathra bohartiella* Opler*
Eupelmus sp.	*Cameraria shenaniganensis* Opler and Davis*
	Prodoxus coloradensis Riley*
Halticoptera sp.	*Calcomyza* sp.* (*Xanthium strumarium* L.)
	Liriomyza sp. (*Lantana camara* L.)
Horismenus fraternus (Fitch)	*Phyllonorycter* sp. (*Quercus agrifolia* Nee)
	Tischeria arizonica Braun*
Horismenus texanus Girault	*Phyllonorycter felinelle* Heinrich*
Lyrcus justicia Girault	*Liriomyza* sp. (*Salvia mellifera* Greene)
Mauleus nigritus (Howard)	*?Stigmella* sp.* (*Rhamnus californica* Eschsch.)
Mesopolobus sp.	*Cameraria sempervirensella* Opler and Davis*
	Coleophora sp. (*Aster chilensis* Nees)
	Tischeria sp. (*Ceanothus greggii* Gray)
Microdontomerus anthonomi Crawford	*Coelopocta glutinosi* (Wlsm.)*
Miotropis californicus Girault	*Apopthesis congregata* Braun*
	Tischeria sp.* (*Quercus alvordiana* Eastw.)
Neochrysocharis arizonensis (Crawford)	*Liriomyza sativae* Blanchard*
Neochrysocharis diastatae (Howard)	Agromyzidae
	Coptodisca cercocarpella Braun*
Neochrysocharis diastatae (Howard)	*?Marmara* sp.* (*Ceanothus greggii* Gray)
	Neurobathra bohartiella Opler*
	Phyllonorycter incanella (Wlsm.)*
	?Stigmella sp.* (*Rhamnus californica* Eschsch.)
	Tischeria sp.* (*Malacothamnus* sp.)

Table 2. Continued.

Parasitoid species	Host species*
Parablastothrix nearctica Miller	*Stigmella variella* (Braun)*
	Stigmella sp. (*Ceanothus* sp., *Prunus ilicifolia* (Nutt.))
Ageniaspis bicoloripes (Girault)	*Caloptilia* sp.* (*Acer macrophyllum* Pursh.)
	Cameraria diabloensis Opler and Davis*
	Cameraria gaultheriella Wlsm.*
	Cameraria ulmella (Cham.)*
	Cameraria prob. *wislizeniella* Opler*
	Cameraria n. sp.* (*Quercus vaccinifolia* Kellogg)
	Phyllonorycter sp. (*Quercus agrifolia* Nee)
	Stigmella inconspicuella Newton and Wilkinson*
	?*Stigmella* sp. (*Rhamnus californica* Eschsch.)*
Pediobius acantha (Walker)	*Chromatomyia syngenesiae* Hardy
Pediobius albipes (Provancher)	*Antispila aurirubra* Braun*
Pnigalio boharti Yoshimoto	*Cameraria sempervirensella* Opler and Davis*
Pnigalio brachysellus Yoshimoto	*Cameraria sempervirensella* Opler and Davis*
Pnigalio coloni (Girault)	*Chromatomyia syngenesiae* Hardy*
	Liriomyza sp.* (*Datisca glomerata* (Presl.))
	Marmara gulosa Guillén and Davis*
	Phyllocnistis sp.* (*Prunus ilicifolia* (Nutt.)
Pnigalio flavipes (Ashmead)	*Antispila aurirubra* Braun*
	Apophthisis congregata Braun*
	Lyonetia ?*prunifoliella* (Hübner)*
	Cameraria agrifoliella (Braun)*
	Cameraria sempervirensella Opler and Davis*
	Lyonetia candida Braun*
	Mompha cephalonthiella (Cham.)*
	Paraleucoptera heinrichi Jones*
	Phyllonorycter deserticola Davis and Desc.*
	Phyllonorycter manzanitae Braun*
	Tischeria sp. (*Aster* sp., *Quercus nigra* L.)
Pnigalio levis Yoshimoto	*Caloptilia palustriella* Braun*
	Cameraria sp.* (*Quercus wislizenii* A. DC.)
	?*Phyllocnistis* sp.* (*Vitis californica* Benth.)
	Phyllonorycter sp.* (*Quercus agrifolia* Nee)
Pnigalio maculipes (Crawford)	*Cameraria sempervirensella* Opler and Davis*
Pnigalio uroplatae (Howard)	*Cameraria mediodorsella* (Braun)*
	Tischeria arizonica Braun*
Pteromalus sp.	*Cameraria lobatiella* Opler and Davis*
Spalangia sp.	*Liriomyza* sp.* (*Datisca glomerata* (Presl.))
Sympiesis bimaculatipennis (Girault)	*Caloptilia palustriella* Braun*
Sympiesis sericicornis (Nees)	*Caloptilia palustriella* Braun*
	Phyllonorycter crugatus Davis and Desc.*
	Phyllonorycter nipigon (Freeman)*
	Phyllonorycter salicifoliella (Clem.)
Sympiesis sericicornis (Nees)	?*Periploca* sp. (*Simmondsia chinensis* Link.)
Sympiesis dolichogaster Ashmead	*Cameraria sempervirensella* Opler and Davis
	Phyllonorycter holodisci (Braun)*
Sympiesis marylandensis Girault	*Cameraria agrifoliella* (Braun)*
	Cameraria shenaniganensis Opler and Davis*
	Cameraria wislizeniella Opler*
	Caloptilia diversilobiella Opler*
	Caloptilia invariabilis Braun*
	Caloptilia sp. (coastal population)* (*Salix* sp.)
	Caloptilia sp.* (*Acer macrophyllum* Pursh.)

Table 2. Continued.

Parasitoid species	Host species*
	Neurobathra bohartiella Opler*
	Tischeria simulata Braun*
	Parornix sp. (*Prunus virginiana* L., *Prunus* sp.)
	Phyllonorycter deserticola Davis and Desc.*
	Phyllonorycter erugatus Davis and Desc.*
	Phyllonorycter felinelle Heinrich*
	Phyllonorycter nipigon (Freeman)*
	Phyllonorycter ribefoliae (Braun)*
	Phyllonorycter salicifoliella (Clem.)
	Phyllonorycter sp. (*Amelanchier* sp.)
	Tischeria consanguinea Braun*
	Tischeria purinosella Cham.*
	Tischaeria sp. (*Quercus texana* Buckley)
Sympiesis stigmata Girault	*Apophthisis congregata* Braun*
	?*Periploca* sp. (*Simmondsia chinensis* (Link.))
	Phyllonorycter arbutusella Braun*
	Phyllonorycter manzanitae Braun*
	Phyllonorycter nipigon (Freeman)*
	Tischeria arizonica Braun*
	Tischeria omissa Braun*
	?*Tischeria* sp. (*Aster* sp.)
Thinodytes caroticus Heydon	*Calcomyza* sp. (*Xanthium strumarium* L.)
Trichomalopsis sp.	Chrysomelidae*
	?*Periploca* sp. (*Simmondsia chinensis* (Link.))*
Zagrammosoma americanum Girault	*Paraleucoptera albella* (Cham.)*
	Phyllonorycter nipigon (Freeman)*
Zagrammosoma centrolineatum Crawford	*Cameraria* sp. (*Quercus turbinella* Greene)
Zagrammosoma hobbesi LaSalle	*Coelopoeta glutinosi* (Wlsm.)*
	Coelopoeta n. sp.* (*Phacelia* sp.)
Zagrammosoma mirum Girault	*Tischeria* sp.* (*Ceanothus greggii* Gray)
Zagrammosoma multilineatum (Ashmead)	*Phyllonorycter nipigon* (Freeman)*
	Tischeria simulata Braun*
	Tischeria zelleriella Cham.*

* Indicates previously unrecorded host for that taxon.

[1] Taxa in the host species column only identified to genus are followed parenthetically by the host plant from which they were reared.

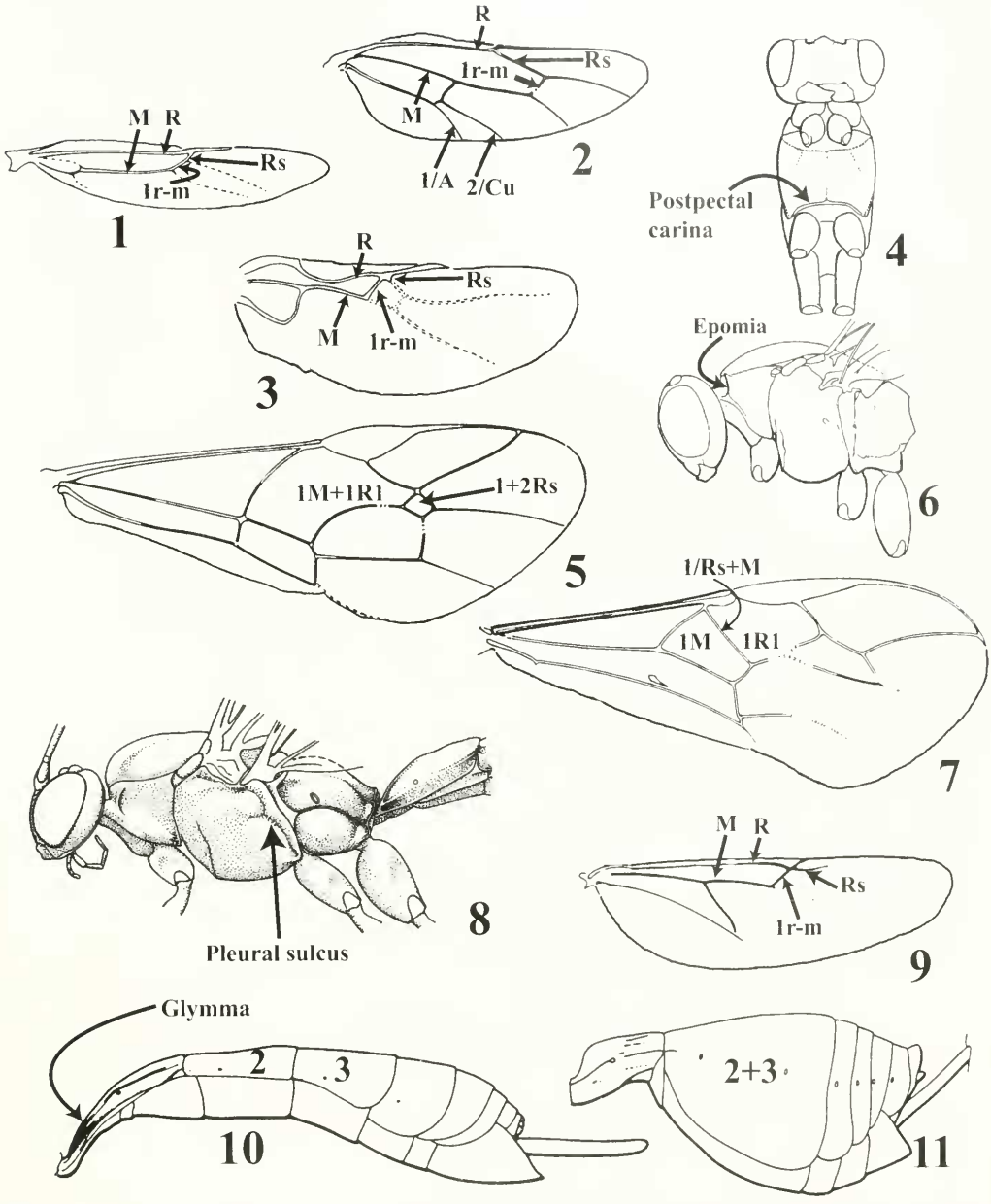
Notes: Ichneumonoidea rearings excluded. No comprehensive work on their biology exists with which to compare our records. All rearing records are included in this table.

fornia (Yu 1998). All mesochorines are obligate hyperparasitoids of endoparasitic Ichneumonoidea (and, rarely, Tachinidae) which parasitize primary hosts of larval Lepidoptera, Symphyta, and Coleoptera, and nymphal and adult Hemiptera and Psocoptera (Wahl 1993). Although some authors (Carlson 1979) place credence in reports of mesochorines acting as primary parasitoids, Wahl (1993) expressed doubt about these records.

Subfamily Pimplinae

3. Genus *Pimpla* Fabricius (Fig. 15)

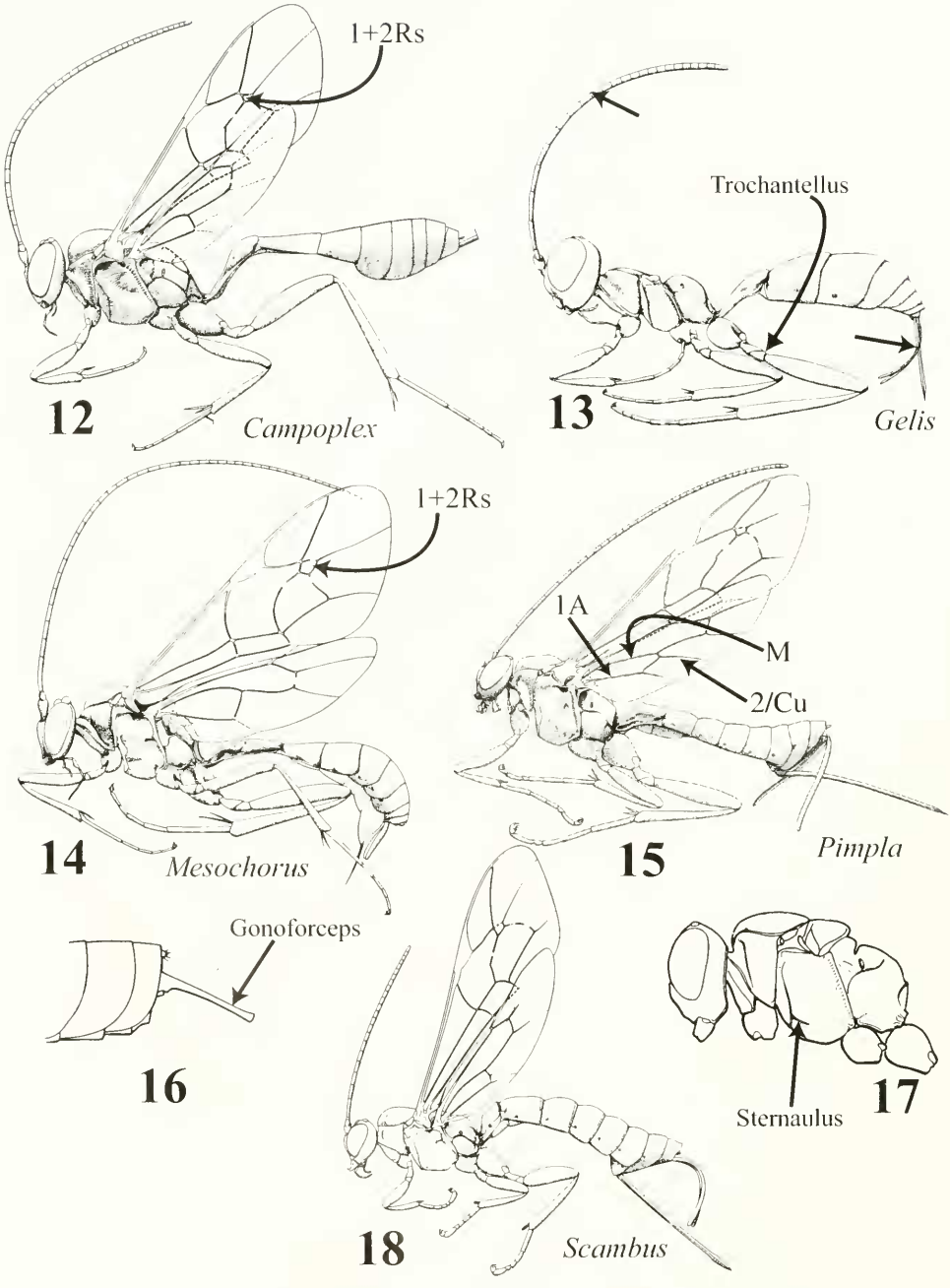
Diagnosis.—Eye not emarginate opposite antennal socket. Supra-antennal area black. Pleural sulcus (= mesopleural suture) without distinct angulation opposite scrobe. Fore tarsal claw of female simple. Hind tibia fuscous with median pale band, apex thus being dark. Vein 2-cu of hind wing meeting vein cu-a distinctly



Figs. 1–11. 1, 6, 9, Ichneumonoidea: 1, 9, hind wings. 6, lateral mesosoma. 2, 4, 10, Ichneumonidae: 2, hind wing. 4, ventral mesosoma. 10, lateral gaster. 5, Ichneumonidae: Mesochorinae, fore wing. 3, 7–8, 11, Braconidae: 3, microgastrine hind wing. 7, fore wing. 11, lateral mesosoma. 8, *Dolichotomius* sp., lateral habitus.

closer to vein M than vein 1A. Ovipositor tip straight, not abruptly downcurved.

Notes.—Twenty species of this genus have been described from the Nearctic, with seven of them occurring in California (Townes and Townes 1960, Carlson 1979). They are idiobiont endoparasitoids of Lepidoptera pupae. Townes referred to

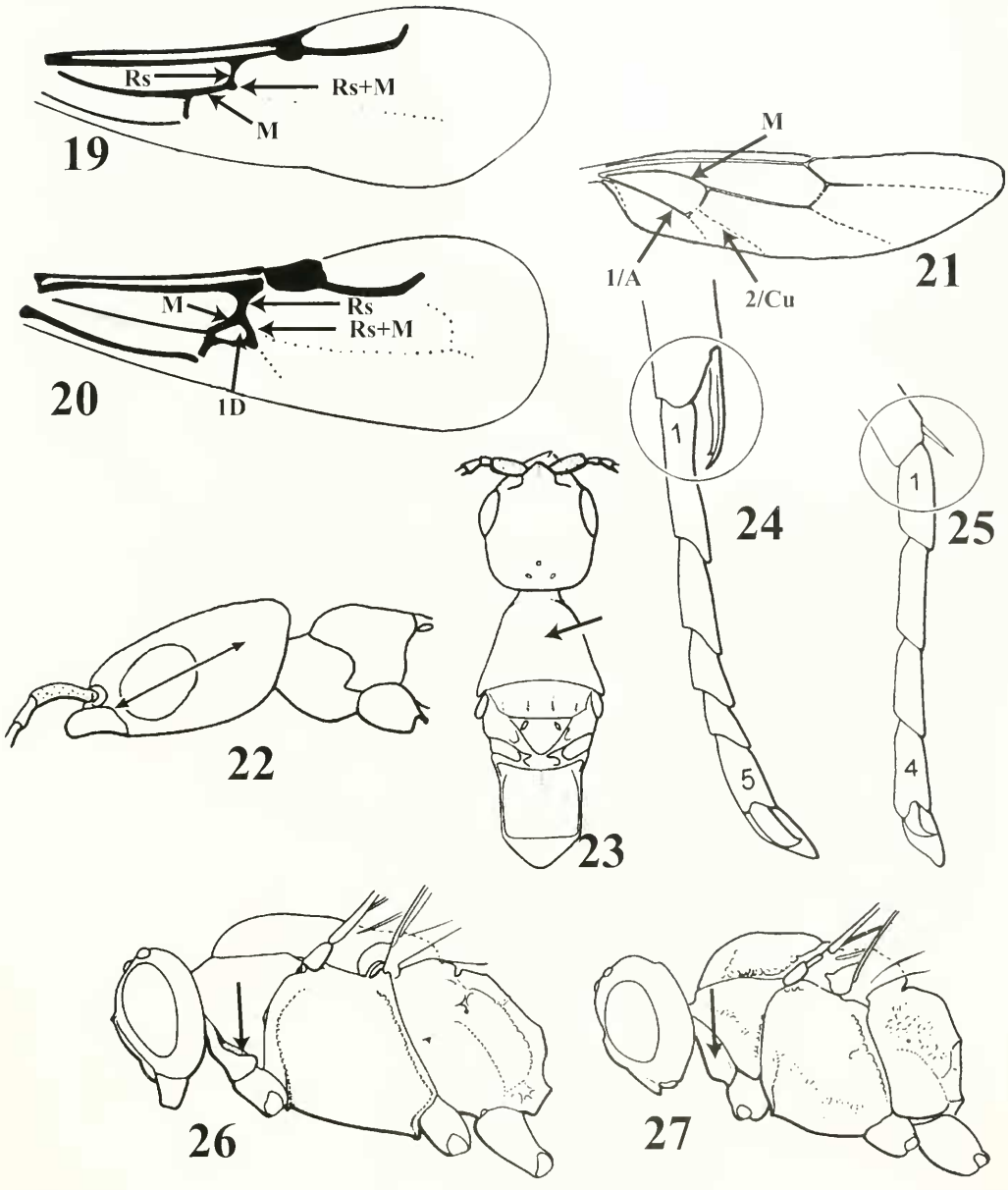


Figs. 12–18. 12–15, 18, Ichneumonidae, habitus: 12, *Campoplex* sp. 13, *Gelis* sp. 14, *Mesochorus* sp. 15, *Pimpla* sp. 18, *Scambus* sp. 16, *Mesochorus* sp., male gonoforceps. 17, Ichneumonoidea, sternaulus.

the genus as "*Coccygominus*", a result of his idiosyncratic system of nomenclature (see Wahl & Mason (1995) for details); *Pimpla*, however, is the correct name.

4. Genus ***Scambus*** Hartig
(Fig. 18)

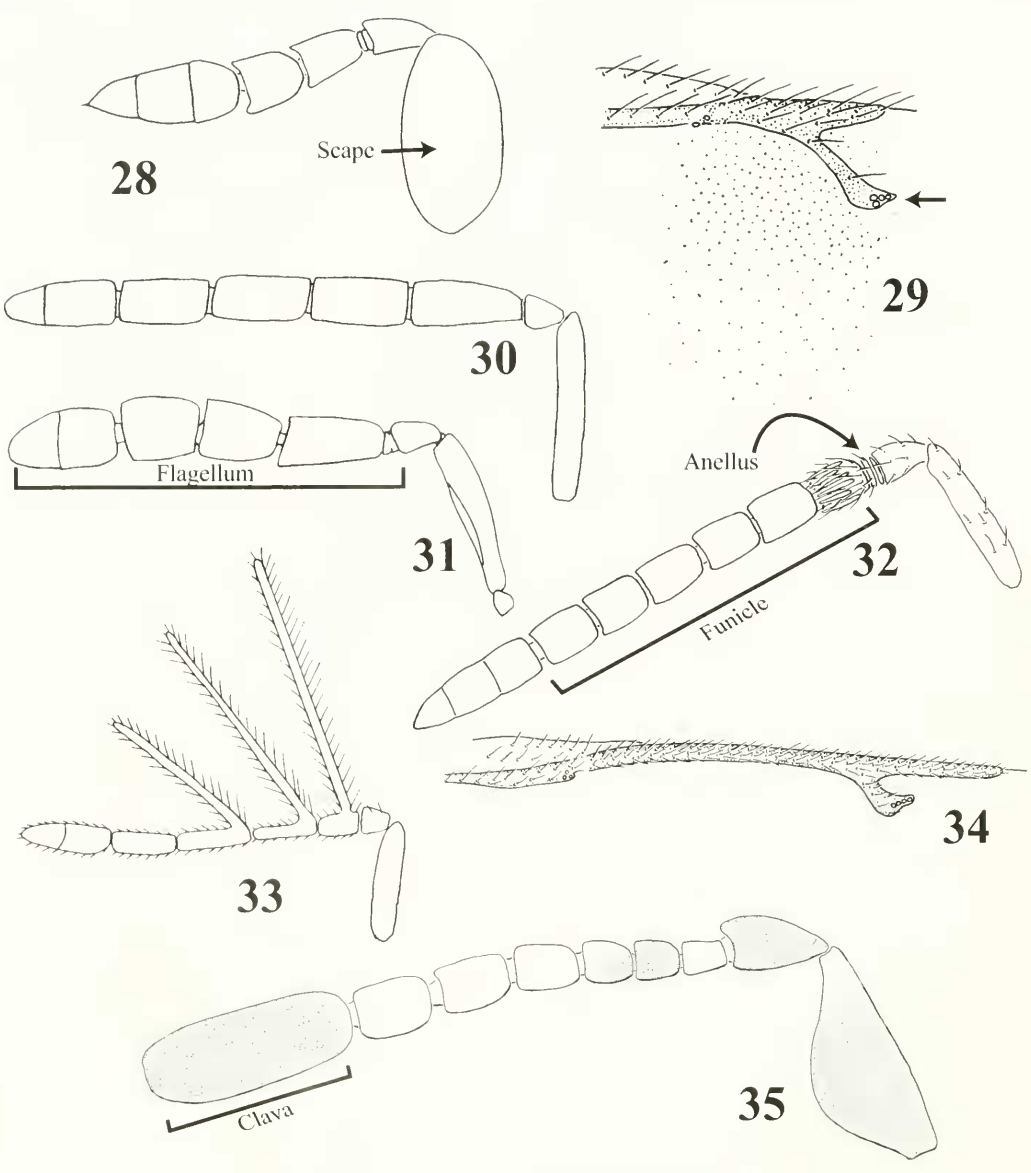
Diagnosis.—Eye not emarginate opposite antennal socket. Supra-antennal area



Figs. 19–27. 19–20, Bethylidae: fore wings. 21, Ichneumonidae, hind wing. 22, Bethylidae: prognathous head. 23, Bethylidae, dorsal mesosoma. 24–25, Chalcidoidea, protarsi, 24, 5-segmented with a bifid spur. 25, 4-segmented with a straight spur. 26–27, Ichneumonidae, lateral mesosoma.

black. Pleural sulcus with distinct angulation opposite scrobe. Fore tarsal claw of female with large basal lobe. Hind tibia with apical and subapical dark bands, extreme base thus being pale. Vein 2-cu of hind wing meeting vein cu-a more or less equidistant between veins M and 1A. Ovipositor tip straight, not abruptly downcurved.

Notes.—Scambus (*sensu* Fitton et al. 1988) is Holarctic and Neotropical in distribution. Nineteen species have been de-



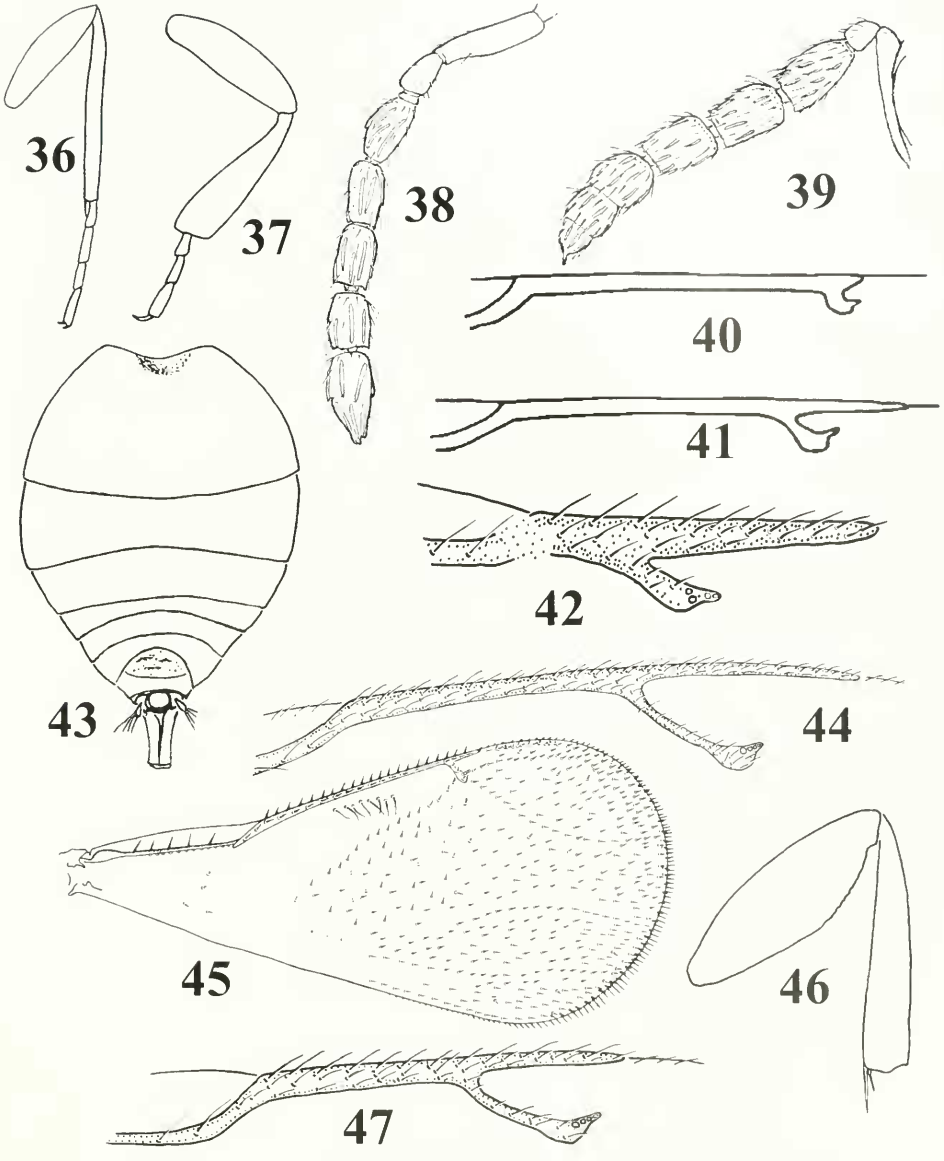
Figs. 28–35. 28, *Diaulinopsis callichroma*, male antenna. 29, *Parablastothrix nearctica*, fore wing venation. 30–31, 33, *Sympiesis* sp., female: 30–31, antenna. male: 33, antenna. 32, *Thinodytes* sp., antenna. 34, *Brachymeria* sp., fore wing venation. 35, *Ageniaspis bicoloripes*, antenna.

scribed from the Nearctic, with 12 of these occurring in California (Carlson 1979). The species are idiobiont ectoparasitoids of the larvae, pre-pupae, or pupae of small Lepidoptera in buds, fruits, leaf rolls, and leaf mines.

Subfamily Campopleginae

5. Genus *Campoplex* Gravenhorst (Figs. 12, 26)

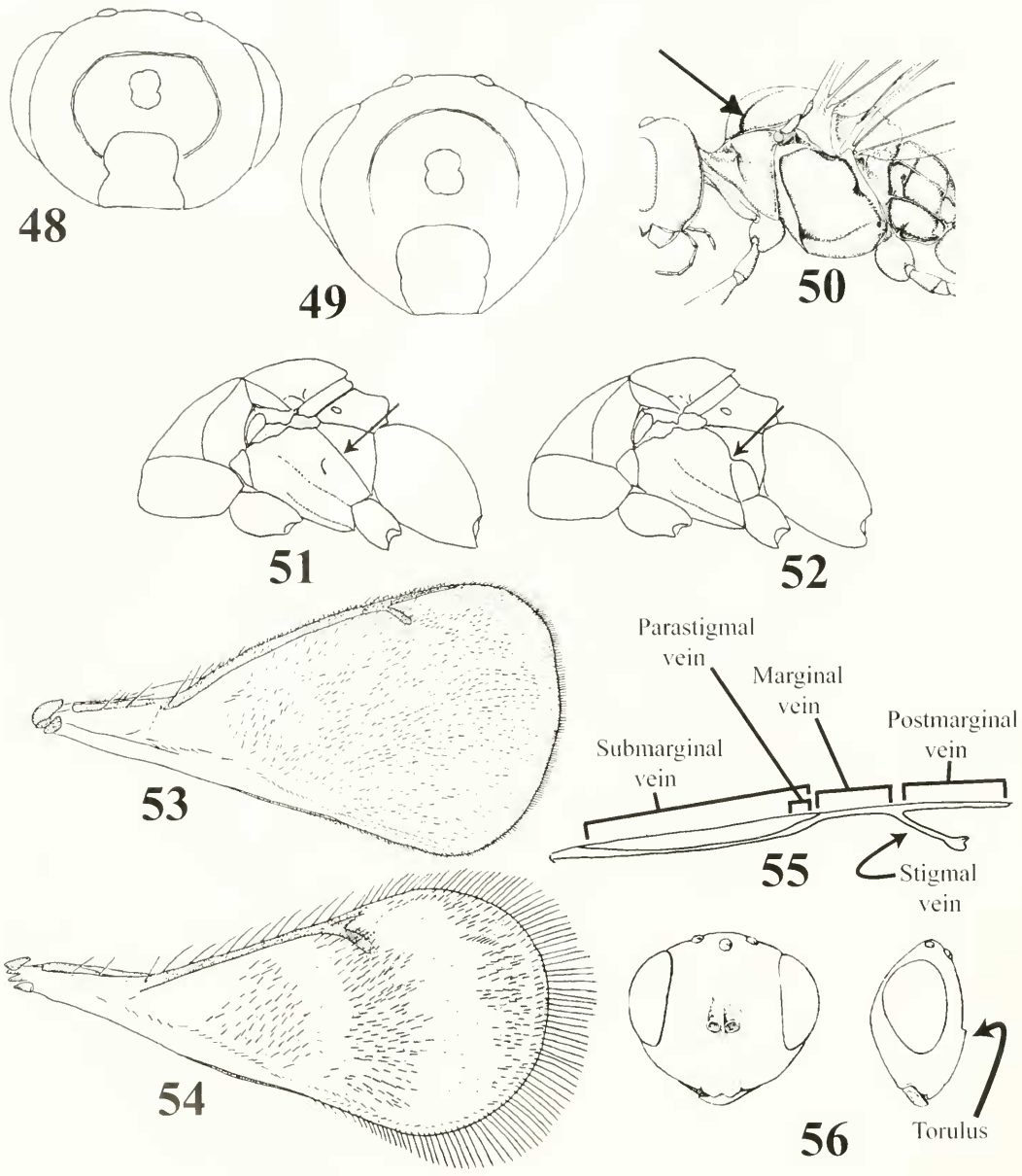
Diagnosis.—Eye not emarginate opposite antennal socket. Propodeum with



Figs. 36–47. 36–37, Chalcidoidea, hind legs. 38–39, *Pnigalio* sp., antenna. 40–41, Torymidae, fore wing venation. 42, *Ageniaspis bicoloripes* Girault, fore wing venation. 43, Torymidae, dorsal gaster. 44, *Mesopolobus* sp., fore wing venation. 45, *Euderus* sp., fore wing. 46, *Microdontomerus* sp., hind leg. 47, *Trichomalopsis* sp., fore wing venation.

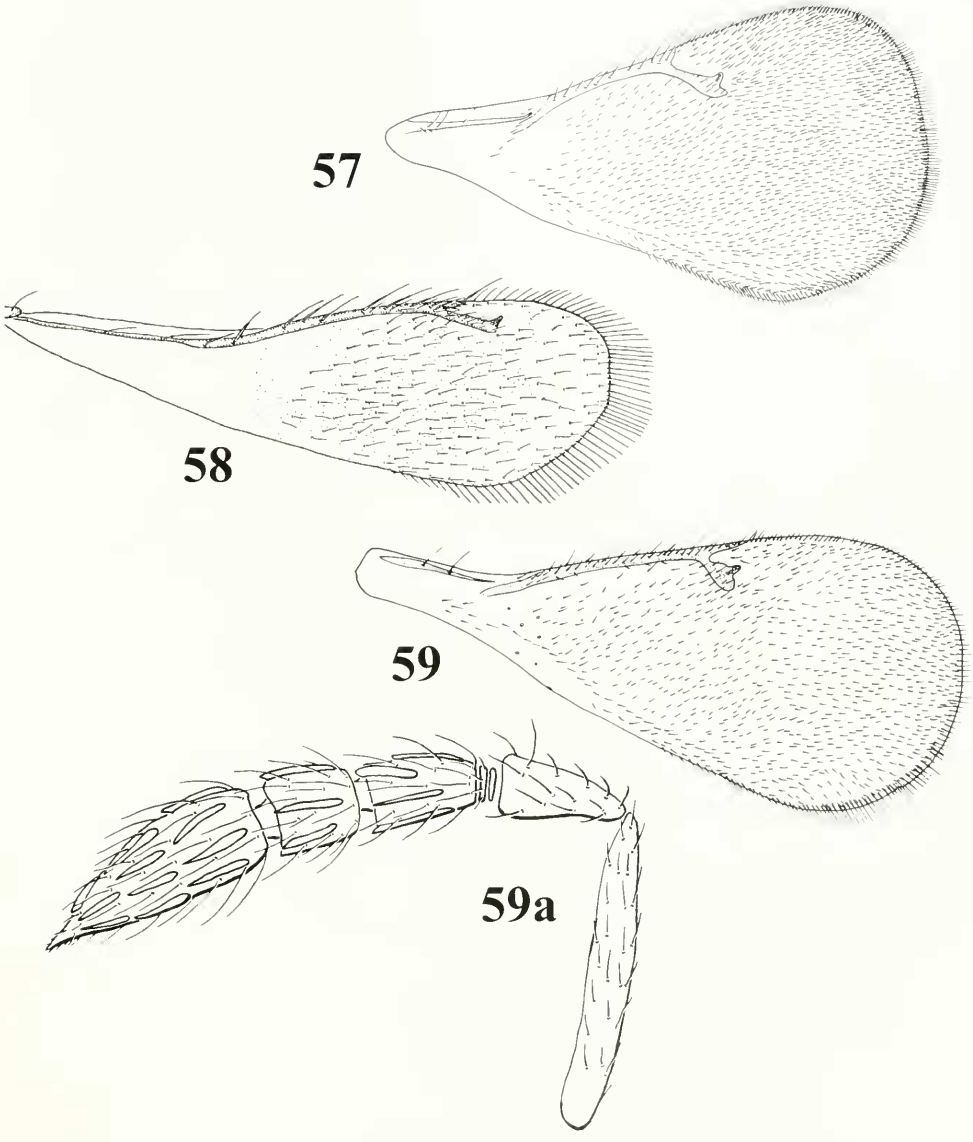
combined areola and petiolar area not forming a trough; apex of propodeum not reaching middle of hind coxa. Vein 2-cu of hind wing basally complete. Petiole of metasomal segment 1 cylindrical at basal 0.3 (not quadrate or trapezoidal in cross-section), suture separating tergite and sternite at midheight, and sternite noticeably convex and produced. Glymma weak, present only as shallow groove. Ovipositor ~2.0× as long as apical depth of metasoma. Male with apex of gonoforceps without semicircular notch.

Notes.—This large, cosmopolitan genus



Figs. 48–56. 48–49, Torymidae, posterior head. 50, *Bathythrix* sp.: lateral mesosoma. 50–51, Toryimdae: 50, mesosoma with straight mesopleural-metapleural separation; 51, mesosoma with sinuous mesopleural-metapleural separation. 53, *Chrysocharis* sp.: fore wing. 54, *Closterocerus* sp.: fore wing. 55–56, *Pteromalus* sp.: 55, fore wing venation; 56, frontal and lateral head.

has 32 described species in the Nearctic region, with seven of these known from California (Carlson 1979, Townes 1970b); there are probably five times as many undescribed species. They are koinobiont endoparasitoids; the hosts are microlepidoptera that feed in concealment (such as leaf rolls, buds, and cases).



Figs. 57–59a. 57, *Baryscapus* sp., fore wing. 58, *Cirrospilus* n.sp., fore wing. 59, *Neochrysocharis* sp., fore wing. 59a, *Cirrospilus* n. sp., antenna.

Subfamily Cryptinae

6. Genus *Diaglyptidea* Viereck

Diagnosis.—Both sexes macropterous. Mandible without sub-basal swelling. Clypeus with apical 0.3 strongly inflexed and covered with brush of long setae; apex without denticles. Center of pronotum with median longitudinal carina; lateral face with epomia. Mesoscutum with notaulus not reaching middle; surface matte. Cell 1+2Rs of fore wing open.

Notes.—This genus is found in the Holarctic and Neotropical regions and contains at least 22 species (Townes 1970a). The undescribed species reared in this

study is the first record from California. Host records are lacking; the wasps are presumably idiobiont ectoparasitoids.

7. Genus *Encrateola* Strand

Diagnosis.—Both sexes macropterous. Mandible without sub-basal swelling. Clypeus weakly convex and without brush of long setae; apex without denticles. Center of pronotum with median longitudinal carina; lateral face with epomia. Mesoscutum with notaulus not reaching middle; surface smooth to weakly matte. Cell 1+2Rs of fore wing closed.

Notes.—*Encrateola* is found worldwide except for Australia and contains at least 13 species (Townes 1970a). The undescribed species reared in this study is the first record from California. Host records are lacking; the wasps are presumably idiobiont ectoparasitoids.

8. Genus *Bathythrix* Foerster (Fig. 50)

Diagnosis.—Both sexes macropterous. Mandible without sub-basal swelling. Clypeus flat and without brush of long setae; apex with two strong median denticles. Center of pronotum without median longitudinal carina; lateral face with epomia. Mesoscutum with notaulus reaching beyond middle; surface polished. Cell 1+2Rs of fore wing closed.

Notes.—*Bathythrix* has a Holarctic distribution, with 25 species recorded from the Nearctic; only two are known from California (Townes 1983). Species in this genus attack small cocoons, including those of Braconidae and Ichneumonidae. They are idiobiont ectoparasitoids.

Family BRACONIDAE

Readers are referred to Whitfield and Wagner (1991) for a key to the Holarctic genera of Braconidae known to parasitize leafminers. Reared braconids included in this study are only incorporated into Tables 1, 3.

Table 3. Families and genera of parasitic hymenoptera reared from native leafminers in California.

BRACONIDAE*	**EULOPHIDAE**
A. *Adelius*	14. *Diglyphus*
B. *Apanteles*	15. *Cirrospilus*
C. *Bassus*	16. *Zagrammosoma*
D. *Cantharoctonus*	17. *Diaulinopsis*
E. *Chelonus*	18. *Pnigalio*
F. *Colastes*	19. *Sympiesis*
G. *Deuterixys*	20. *Hemiptarsenus*
H. *Dolichogenidea*	21. *Elachertus*
I. *Guamptodon*	22. *Miotropis*
J. *Habrobracon*	23. *Baryscapus*
K. *Hormius*	24. *Aprostocetus*
L. *Mirax*	25. *Horismenus*
M. *Paradelius*	26. *Pediobius*
N. *Parahormius*	27. *Chrysocharis*
O. *Paroligoneurus*	28. *Achrysocharoides*
P. *Pholetesor*	29. *Neochrysocharis*
Q. *Rhysipolis*	30. *Closterocerus*
R. *Stiropius*	31. *Euderus*
S. *Viridipyge*	**EUPELMIDAE**
ICHNEUMONIDAE	32. *Eupelmus*
1. *Gelis*	33. *Brasema*
2. *Mesochorus*	**EURYTOMIDAE**
3. *Pimpla*	34. *Eurytoma*
4. *Scambus*	**PTEROMALIDAE**
5. *Campoplex*	35. *Callimerismus*
6. *Diaglyptidea*	36. *Thinodytes*
7. *Encrateola*	37. *Halticoptera*
8. *Bathythrix*	38. *Mauleus*
BETHYLIDAE	39. *Trichomalopsis*
9. *Goniozus*	40. *Mesopolobus*
ENCYRTIDAE	41. *Pteromalus*
10. *Ageniaspis*	42. *Spalangia*
11. *Parablastothrix*	**TORYMIDAE**
CHALCIDIDAE	43. *Microdontomerus*
12. *Conura*	44. *Torymus*
13. *Brachymeria*	

* Taxa of Braconidae indicated by letters to separate from taxa which, indicated by numbers, are treated in the text.

Superfamily Chrysidoidea
Family BETHYLIDAE
Subfamily Bethylinae

9. Genus *Goniozus* Förster (Figs. 19, 20, 22–23)

Diagnosis.—Predominantly black. Head and body dorsoventrally flattened, head prognathous (Fig. 22). Clypeus with strong angular/subangular median lobe, with median polished carina extending

between toruli. Propodeum margined laterally with complete, incomplete or absent transverse carina posteriorly connecting the lateral carinae. Tarsal claws of female bifid, those of male trifid.

Notes.—This cosmopolitan genus, with numerous described and undescribed species, primarily attacks microlepidopteran hosts. There are at least 36 species from the Nearctic and at least 30 from south of the United States (Evans 1978).

Superfamily Chalcidoidea
Family ENCYRTIDAE
Subfamily Encyrtinae

10. Genus ***Ageniaspis*** Dahlbom
(Figs. 35, 42)

Diagnosis.—Tarsi 5-segmented. Funicle at least 6-segmented. Acropleuron swollen and mesocoxa inserted at or anterior to midline of mesopleuron (as in Fig. 61). Cercus usually placed near mid-length of gaster (as in Fig. 61). Clava 1-segmented, rounded (Fig. 35). Postmarginal vein >1.5× as long as stigmal vein (Fig. 42). Scutellum longitudinally striate, appearing almost silky, in contrast to shallowly reticulate, shiny mesoscutum.

Notes.—A genus of 15 described species worldwide with 2 known from the Nearctic region (Miller 1961, Kazmi and Hayat 1998) and one species introduced against citrus leafminer (see Schauff et al. 1998 and references therein). Only *A. bicoloripes* is reported here to occur in California, while *A. citricola* will likely arrive on the heels of CLM. Members of this genus are primarily polyembryonic parasites of larvae of Lepidoptera. At the generic level, most of the host associations reported here are previously recorded (Noyes 1998) genera of the Gracillariidae (*e.g. Cameraria, Phyllonorycter*), with the exception of *Caloptilia* sp. (Gracillariidae) and *Stigmella* spp. (Nepticulidae).

11. Genus ***Parablastothrix*** Mercet
(Figs. 29, 60–61)

Diagnosis.—Tarsi 5-segmented. Funicle at least 6-segmented. Acropleuron swollen and mesocoxa inserted at or anterior to midline of mesopleuron (Fig. 61). Cercus usually placed near mid length of gaster. Eye very nearly touching base of mandible (Fig. 60). Fore wing infuscate in middle ⅓ or less (Fig. 29).

Notes.—One described Nearctic species recorded from central and eastern USA, *P. nearctica* Miller (Miller 1965) and at least one unidentified species (Noyes et al. 1997). At least 16 nominal species worldwide which attack larvae of Lyonetiidae and Nepticulidae. The host *Stigmella variella* (Braun) (Nepticulidae) is newly reported here.

Comments.—Three other damaged and unidentifiable encyrtids, apparently belonging to neither *Ageniaspis* nor *Parablastothrix* (Zolnerowich, pers. comm.), were reared for this study.

Family CHALCIDIDAE
Subfamily Chalcidinae

12. Genus ***Conura*** Spinola
(Fig. 107)

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented. Hind femur enlarged, dentate ventrally. Gaster petiolate, petiole slightly transverse to very long (Fig. 107). Propodeum with spiracle oriented subvertically to nearly longitudinally.

Notes.—Keys are provided by Burks (1940) and Delvare (1992—keys to species groups and *side* group). At least 45 species occur north of Mexico. Hosts consist primarily of cocoons of Lepidoptera but some species attack Coleoptera, Hymenoptera, or are secondary parasites through Ichneumonoidea. New records reported here include rearings from the microlepidopteran families Tischeriidae, Gracillariidae and Elachistidae.

Subfamily Brachymeriinae

13. Genus ***Brachymeria*** Westwood
(Figs. 102–105)

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented (Fig. 105). Hind femur en-

larged, dentate ventrally (Fig. 103). Gaster sessile, petiole in dorsal view not visible (Fig. 102) or evident as a transverse line. Propodeum with spiracle oriented diagonally (Fig. 104).

Notes.—Burks (1960) provided a key to Nearctic species. There are at least 25 species north of Mexico with 2–3 introduced taxa and six species known from California (Bouček 1992—key to species groups). Most species attack Lepidoptera, Diptera and Hymenoptera as primary parasites. Others are secondary parasites on Orthoptera and Lepidoptera through Tachinidae and Sarcophagidae. One species was reared from an unidentified leafminer on *Artemisia* sp. in this study.

Family EULOPHIDAE
Subfamily Eulophinae

14. Genus *Diglyphus* Walker
(Fig. 95)

Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented. Submarginal vein with 3 or more setae dorsally; postmarginal vein at least as long as stigmal vein. Notauli incomplete; scutellum with lateral grooves (Fig. 95). Propodeum without median carina or plica (Fig. 95). Coloration dark metallic. Often confused with *Cirrospilus*, but *Cirrospilus* have complete notauli that reach the posterior margin of the mesoscutum (Fig. 95).

Notes.—Widespread and abundant genus with numerous species. Species of *Diglyphus* are mainly parasitic upon leafmining Diptera on herbaceous plants, but are also known from Lepidoptera on woody plants (Bouček and Askew 1968). Several species are important for biocontrol of Agromyzidae (LaSalle and Parrella 1991). Gordh and Hendrickson (1979) provide a key to species. Four species are reported north of Mexico and all four have been documented in California (Krombein et al. 1979). We record two new hosts for *Diglyphus*, one each in the families Elachistidae and Gracillariidae.

15. Genus *Cirrospilus* Westwood
(Figs. 58, 59a, 114)

Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented. Submarginal vein with 3 or more setae dorsally; postmarginal vein subequal in length to stigmal vein. Notauli complete to posterior margin of the mesoscutum; scutellum with lateral grooves that may be faint (cf. Fig. 102). Propodeum usually without median carina or plica. Coloration metallic to non-metallic and yellow. Wing rarely with infuscation (Fig. 58). Often confused with *Zagrammosoma*, but *Zagrammosoma* have the head vaulted (but also in *Cirrospilus coachellae* Gates) and the notauli turn to intercept the advanced axillae (cf. Fig. 108). The axillae are not advanced in most *Cirrospilus*. *Cirrospilus* resembles *Diglyphus*, but *Cirrospilus* have complete notauli that reach the posterior margin of the mesoscutum (Fig. 114).

Notes.—Over 300 nominal species worldwide, ~24 in North America (Noyes 1998), and at least five (Krombein et al. 1979, Gates 2000) found in California. Species range from parasitic, facultatively hyperparasitic or obligately hyperparasitic (rarely) to gregariously ectoparasitic on numerous cryptically-feeding hosts (Bouček 1959b, 1988, Schauff et al. 1997, Gates 2000). Key only available to the Palaearctic species (Bouček 1959b). Most of the new hosts we report for this genus belong to the Gracillariidae, but also in Lyonetiidae, Tischeriidae and Nepticulidae.

16. Genus *Zagrammosoma* Ashmead
(Figs. 109, 108)

Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented. Head vaulted, extending above dorsal margin of eye (Fig. 109). Submarginal vein with 3 or more setae dorsally; postmarginal vein subequal in length to stigmal vein. Notauli turning to intercept advanced axilla anteriorly (Fig. 108); scutellum with lateral grooves that may be faint (Fig. 108). Propodeum lack-

ing median carina (or only weakly indicated) or plica. Coloration yellow with variously produced longitudinal brown stripes. Wing often distinctly infuscate. Commonly confused with *Cirrospilus* (see discussion under that genus).

Notes.—Primarily a New World genus that attacks leafmining Lepidoptera and Diptera (Gordh 1978, Bouček 1988, LaSalle 1989). Keys to ~10 Nearctic species may be found in Gordh (1978) and LaSalle (1989) with at least five species known from California (Krombein et al. 1979). New host family records are reported for the Gracillariidae, Elachistidae, Tischeriidae and Lyonetiidae.

17. Genus *Diaulinopsis* Crawford (Fig. 28)

Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented, male with enlarged scape (Fig. 28). Submarginal vein with 3 or more setae dorsally; postmarginal vein about twice as long as stigmal vein. Notauli complete and extending to transscutal articulation; scutellum without lateral grooves (as in Fig. 99). Propodeum without median carina or plica. Commonly confused with *Diglyphus* but *Diaulinopsis* lacks scutellar grooves.

Notes.—Gordh and Hendrickson (1979) provide a key to the two Nearctic species, one of which occurs in California. We record only one new host association, *Liriomyza sativae* Blanchard (Agromyzidae), for *Diaulinopsis callichroma* Crawford.

18. Genus *Pnigalio* Schrank (Figs. 38–39, 97–98)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented (rarely 3-segmented) (Figs. 38–39). Submarginal vein with 3 or more setae dorsally; postmarginal vein present, longer than stigmal vein. Notauli incomplete (Fig. 97); scutellum sculptured, lacking lateral grooves. Propodeum glabrous with complete median carina, plica, and usually costula (Fig. 98). This genus may be confused with *Sympiesis*, which shares 4 funicular segments, incomplete notauli, and the scutellum lacks sublateral grooves, but the plicae and costulae of *Pnigalio* distinguishes it from *Sympiesis*.

Notes.—This genus is primarily Holarctic containing typically polyphagous parasitoids of leafmining and gall-forming insects, usually Lepidoptera. Also documented from Diptera and Coleoptera (Miller 1970, Yoshimoto 1983). Approximately 17 species occur in the Nearctic region with seven of these known from California (Krombein et al. 1979, Yoshimoto 1983, Noyes 1998). Numerous new specific host records are presented here from following lepidopteran families: Tischeriidae, Lyonetiidae, Gracillariidae, Momphidae and Heliozelidae.

19. Genus *Sympiesis* Förster (Figs. 30–31, 33, 99)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented. Submarginal vein with 3 or more setae dorsally; postmarginal vein present, longer than stigmal vein. Notauli incomplete (Fig. 99); scutellum sculptured, lacking lateral grooves. Propodeum glabrous with complete median carina, lacking plica and costula. This genus may be confused with *Pnigalio*, which shares 4 funicular segments, incomplete notauli, and the scutellum lacking sublateral grooves, but lacks the plica and (usually) costula possessed by *Pnigalio*.

Notes.—Four of the twenty nominal species known from the Nearctic region occur in California (Noyes 1998). Species of this genus are solitary or gregarious parasitoids of cryptically-feeding hosts, usually Lepidoptera (Bouček 1959a, Miller 1970, Storozheva 1982). Many species are presented here as new host associations, the majority belonging to the Gracillariidae and Tischeriidae.

20. Genus *Hemiptarsenus* Westwood (Fig. 90)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented. Submarginal vein with 3 or

more setae dorsally; postmarginal vein present, longer than stigmal vein. Notauli incomplete. Torulus situated above lower eye margin, thus scape extends beyond level of vertex.

Notes.—Two of the 17 nominal species known from the Nearctic region also occur in California (Noyes 1998, also see Schauff and LaSalle 1993). All known hosts are leafminers, typically Diptera. The wasps recovered in this study were associated with species of *Phyllonorycter* (Gracillariidae) on *Q. chrysolepis*.

21. Genus *Elachertus* Spinola (Figs. 100–101)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented. Submarginal vein with 3 or more setae dorsally; postmarginal vein present, longer than stigmal vein. Notauli complete (Fig. 100); scutellum with lateral grooves that converge posteromedially. Propodeum with complete median carina, lacking plicae (Fig. 101).

Notes.—The six Nearctic species in this genus are often polyphagous on small larvae of Lepidoptera in concealed situations (Schauff 1985, Bouček 1988). Three of these species are widely distributed in the Nearctic, with two documented from California. All hosts presented here are previously unknown for this genus and belong to the lepidopteran families Gracillariidae and Tischeriidae.

22. Genus *Miotropis* Thomson (Fig. 96)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented. Submarginal vein with 3 or more setae dorsally; postmarginal vein present, longer than stigmal vein. Notauli incomplete (Fig. 96); scutellum sculptured, lacking lateral grooves, but if lateral grooves present they do not or only slightly converge posteromedially. Propodeum glabrous with complete median carina, lacking plica and costula (Fig. 111). This genus may be confused with *Pnigalio*, which shares 4 funicular segments, incomplete notauli and the scutellum lacks sublateral grooves, but *Miotropis* lacks the plica and (usually) costula possessed by *Pnigalio*. It may also be confused with *Elachertus*, but the submedial grooves on the scutellum converge posteromedially (often contacting each other) in *Elachertus*.

Notes.—This genus contains at least nine species in the Nearctic region that are known to attack Lepidoptera (see Schauff and LaSalle 1993) and at least one species occurs in California (Noyes 1998). All hosts presented here are previously unknown for this genus and belong to Gracillariidae and Tischeriidae.

Subfamily Tetrastichinae

23. Genus *Baryscapus* Förster (Figs. 57, 93–94)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented. Submarginal vein with 2 or more setae dorsally; postmarginal vein reduced or absent. Notauli complete; midlobe of mesoscutum with several scattered setae or with adnotaular row of setae; scutellum with 2 pairs of setae and 2 pairs of longitudinal grooves. Propodeal spiracle with entire rim exposed (Fig. 93). Gaster with longest 2 cercal setae subequal in length with each other and with surrounding gastral setae, straight or slightly curved (Fig. 94). This genus may be confused with *Aprostocetus*, which differs in having the raised lobe of the callus partially covering the outer rim of the spiracle (Fig. 91), and the cercal setae not all subequal, one distinctly longer and sinuate (Fig. 92).

Notes.—This genus contains many species in the Holarctic region that may be parasitoids or hyperparasitoids (Graham 1991, LaSalle 1994), and it is unknown how many species actually occur in California. Two new hosts in the Cosmopterigidae and Tischeriidae are reported as new.

24. Genus *Aprostocetus* Westwood (Figs. 91–92)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented (4-segmented in male). Submarginal vein with 2 or more setae dorsally; postmarginal vein reduced or absent, less than a third as long as stigmal vein. Notauli complete; midlobe of mesoscutum with a single adnotaular row of setae; scutellum with 2 pairs of setae and 2 pairs of longitudinal grooves. Propodeum with raised lobe of callus overhanging outer rim of spiracle (Fig. 91). Gaster with cercal setae not all subequal, one distinctly longer and sinuate (Fig. 92). This genus may be confused with *Baryscapus*, see discussion under that genus.

Notes.—This genus is cosmopolitan and abundant with hundreds of species that have a wide host range (Graham 1987, Bouček 1988, LaSalle 1994), and it is unknown how many occur in California. New host species recorded herein include members of Tischeriidae, Gracillariidae, and Lyonetiidae.

Subfamily Entedoninae

25. Genus *Horismenus* Walker (Figs. 84–85)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented (4 in male). Submarginal vein with 2 setae dorsally; postmarginal vein shorter than stigmal vein. Anterior margin of pronotum with carina; notauli incomplete; scutellum with median groove (Figs. 84–85); propodeum with median carina bordered by depressed and often sculptured area (Fig. 85). May be confused with other 'hard-bodied' entedonines such as *Pediobius*, but the propodeal sculpture is unique (Fig. 85).

Notes.—Primarily a New World genus with at least 17 Nearctic species of which at least two are known from California (Noyes 1998). Species of *Horismenus* are parasitic or hyperparasitic (facultative or obligate) on a wide range of hosts (Burks 1971). The species of *Horismenus* recorded here include new host associations for leafmining members of Tischeriidae and Gracillariidae.

26. Genus *Pediobius* Walker (Fig. 86)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented. Submarginal vein with 2 setae dorsally; postmarginal vein subequal to stigmal vein. Anterior margin of pronotum with carina; notauli incomplete; scutellum lacking median groove (Fig. 86); propodeum with paired, posteriorly-divergent median carinae (Fig. 86), with lateral plica. Petiole present and distinct (cf. Fig. 80). May be confused with other 'hard-bodied' entedonines such as *Horismenus*, but its propodeal sculpture is unique (Fig. 86).

Notes.—Primarily an Old World genus, species of *Pediobius* are parasitic or hyperparasitic on a wide range of hosts (Bouček 1965, Kerrich 1973, Peck 1985). Approximately 39 Nearctic species are described with at least two documented from California (Noyes 1998). The *Pediobius* reared in this study were associated with Heliozelidae and Agromyzidae.

27. Genus *Chrysocharis* Förster (Figs. 53, 87)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented (4-segmented in male). Submarginal vein with 2 setae dorsally; postmarginal vein at least 1.5× as long as stigmal vein (Fig. 53). Frontofacial suture V-shaped, rarely transverse; scutellum lacking median groove, with 1 pair of setae (Fig. 87); propodeum usually lacking plicae, incomplete median carina sometimes present. Distinguished from other genera of Entedoninae by the postmarginal vein 1.5× as long as the stigmal vein (Fig. 53).

Notes.—A speciose Holarctic genus with 64 species known from the Nearctic and a host range spanning the Diptera, Lepidoptera, Coleoptera and Hymenoptera (Hansson 1985a, 1987). All of the new associations reported here for *Chrysocharis* are

primarily in the families Agromyzidae, Gracillariidae and Elachistidae.

28. Genus *Achrysocharoides* Girault (Figs. 88–89, 116)

Diagnosis.—Tarsi 4-segmented. Funicle 3-segmented. Submarginal vein with 2 setae dorsally; postmarginal vein at most as long as stigmal vein; stigmal vein lacking radiating setal lines (as in Fig. 59). Frontofacial suture straight, transverse (Fig. 89); mesoscutum and scutellum often pitted (Fig. 88); scutellum lacking median groove, with 1 pair of setae; propodeum lacking plicae and median carina (Fig. 116). *Achrysocharoides* is most commonly confused with other possibly closely related genera: *Neochrysocharis* and *Closterocerus*. All three genera lack a median carina and plica on the propodeum, lack a transverse carina on the pronotum, lack a clypeal suture, and have the postmarginal vein at most as long as the stigmal vein. However, *Neochrysocharis* has the frontofacial sutures V- or Y-shaped (as in Fig. 110) and the mesosoma is never pitted dorsally, while *Closterocerus* has a single radiating line of setae extending from the stigmal vein and has the wing often with infuscate bands (Fig. 54), and is never pitted dorsally. Those specimens of *Achrysocharoides* reared from California leafminers possess mesh-like reticulation, lack the dorsal pitting and are most easily separated by the straight frontofacial suture.

Notes.—This cosmopolitan genus attacks small leafmining Lepidoptera (Yoshimoto 1977, Bryan 1980, Hansson 1985b, Kamijo 1990, 1991). Eighteen Nearctic species are known with one species (*A. zwoelferi* (Delucchi)) reported from British Columbia, Canada and one new California record for *A. villosus* Kamijo presented here. All new host associations for this genus are restricted to members of the Gracillariidae.

29. Genus *Neochrysocharis* Kurdjumov (Figs. 59, 115)

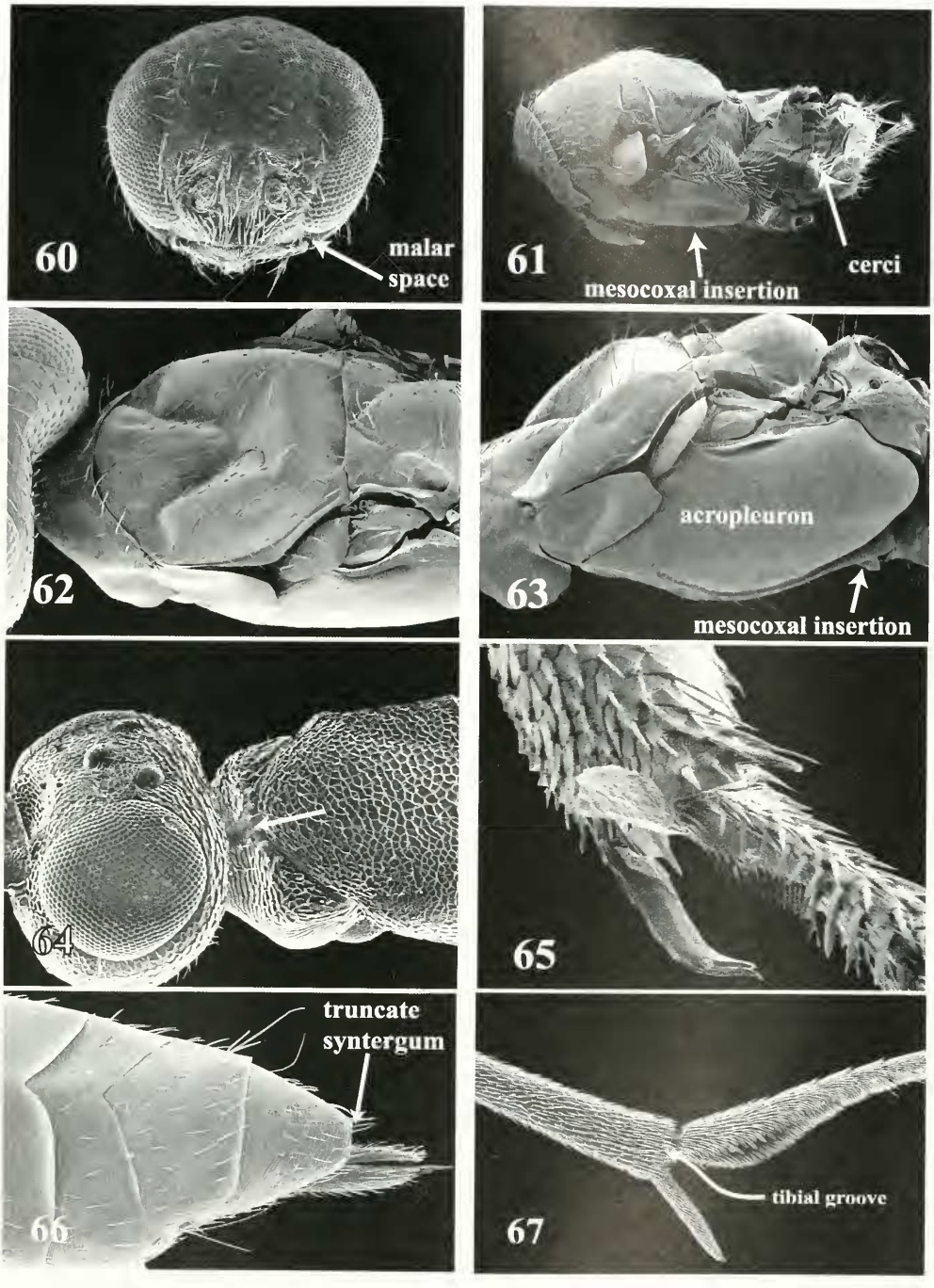
Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented. Submarginal vein with 2 setae dorsally; postmarginal vein shorter than stigmal vein (Fig. 59). Frontofacial sutures shaped like a "V"; mesoscutum and scutellum never pitted; scutellum with 1 pair of setae; propodeum lacking plicae and median carina. Mesopleuron with transepimeral sulcus strongly arched (Fig. 115). Fore wing lacking line of setae radiating apically from stigma.

Notes.—Hansson (1995) provides a key to the 18 species north of Mexico, but 24 nominal taxa are reported by Noyes (1998) as occurring in the Nearctic region with five of these in California. This genus is known from hosts in the Coleoptera, Diptera, Hymenoptera, and Lepidoptera. New host associations for this genus include members of the Agromyzidae, Gracillariidae, Tischeriidae and Heliozelidae.

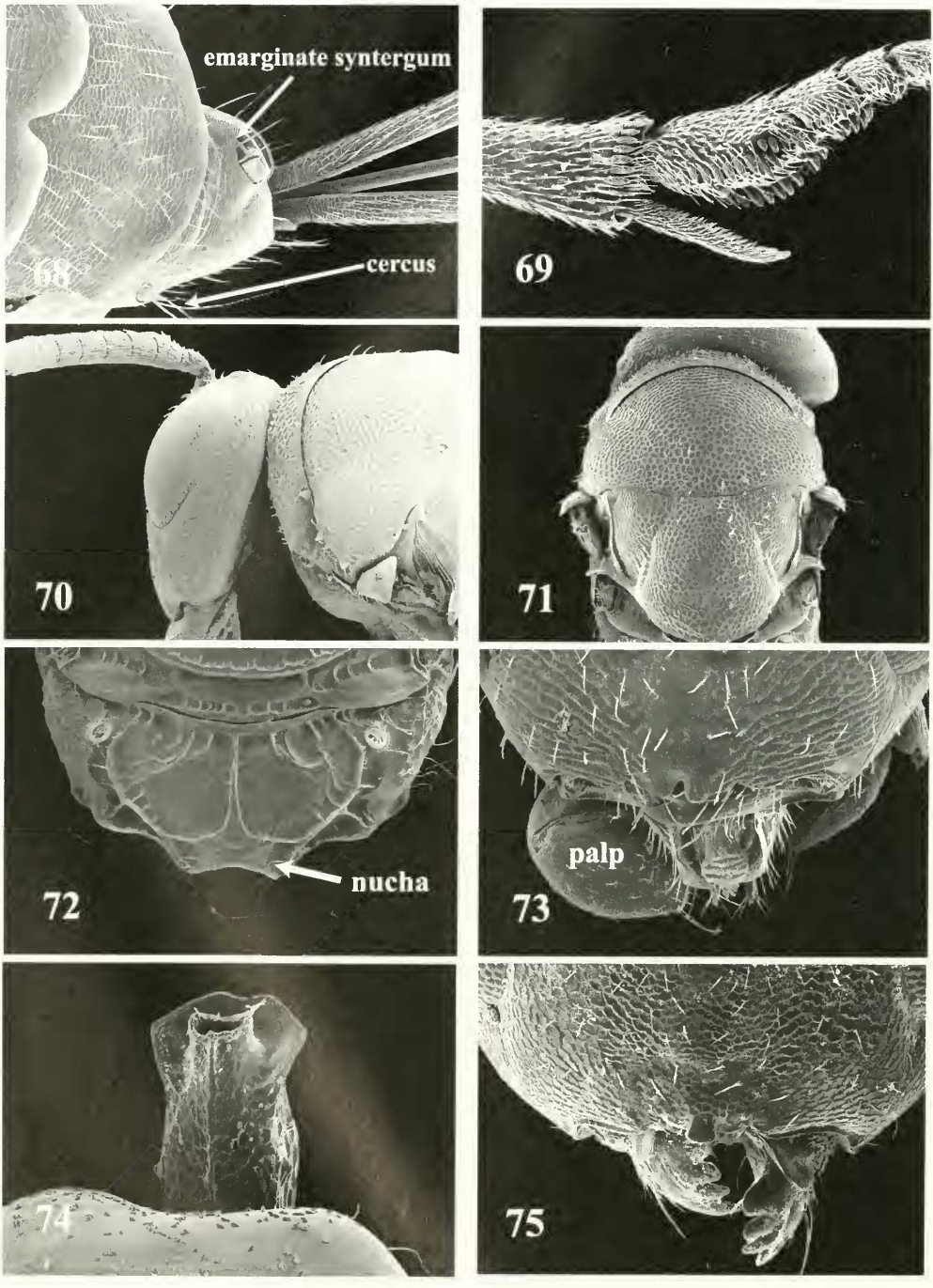
30. Genus *Closterocerus* Westwood (Figs. 54, 110–111, 117)

Diagnosis.—Tarsi 4-segmented. Funicle 2-segmented. Submarginal vein with 2 setae dorsally; postmarginal vein shorter than stigmal vein (Fig. 54). Frontofacial sutures shaped like a "V" (Fig. 110); mesoscutum and scutellum never pitted; scutellum with 1 pair of setae; propodeum lacking plicae and median carina. Mesopleuron with transepimeral sulcus weakly arched (Fig. 117) or straight. Fore wing with a single line of setae radiating apically from stigma (Fig. 54).

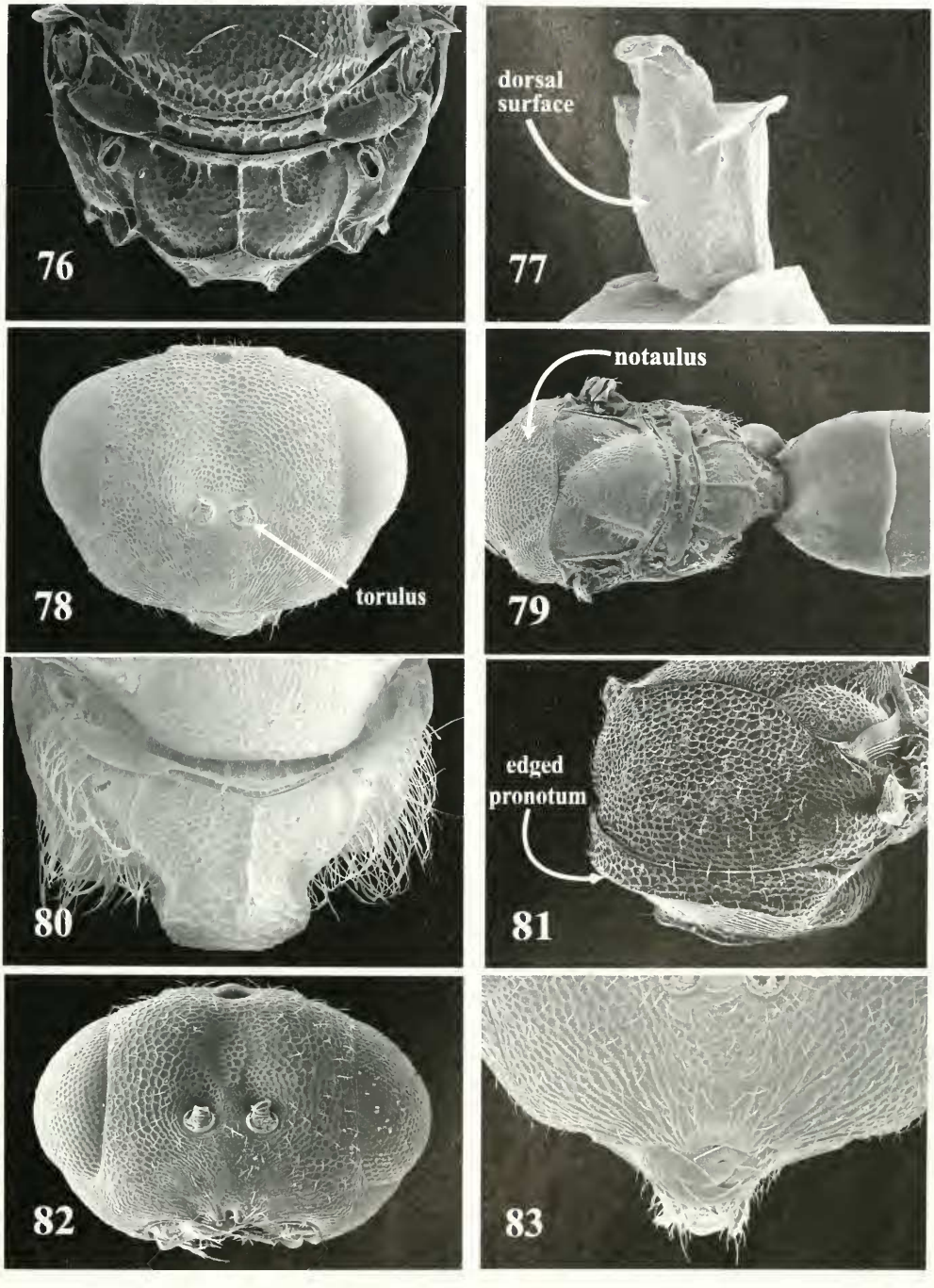
Notes.—Hansson (1994) provides a key to 21 species in the Nearctic region. Of these, nine are known from California. Members of this genus attack a wide variety of insects: Coleoptera, Hemiptera (Psyllidae), leaf mining Diptera, Lepidoptera, and Hymenoptera as well as the eggs of Symphyta. New host associations presented here represent five families of microlepidoptera: Lyonetiidae, Gracillariidae, Tischeriidae, Elachistidae and Cosmopterigidae.



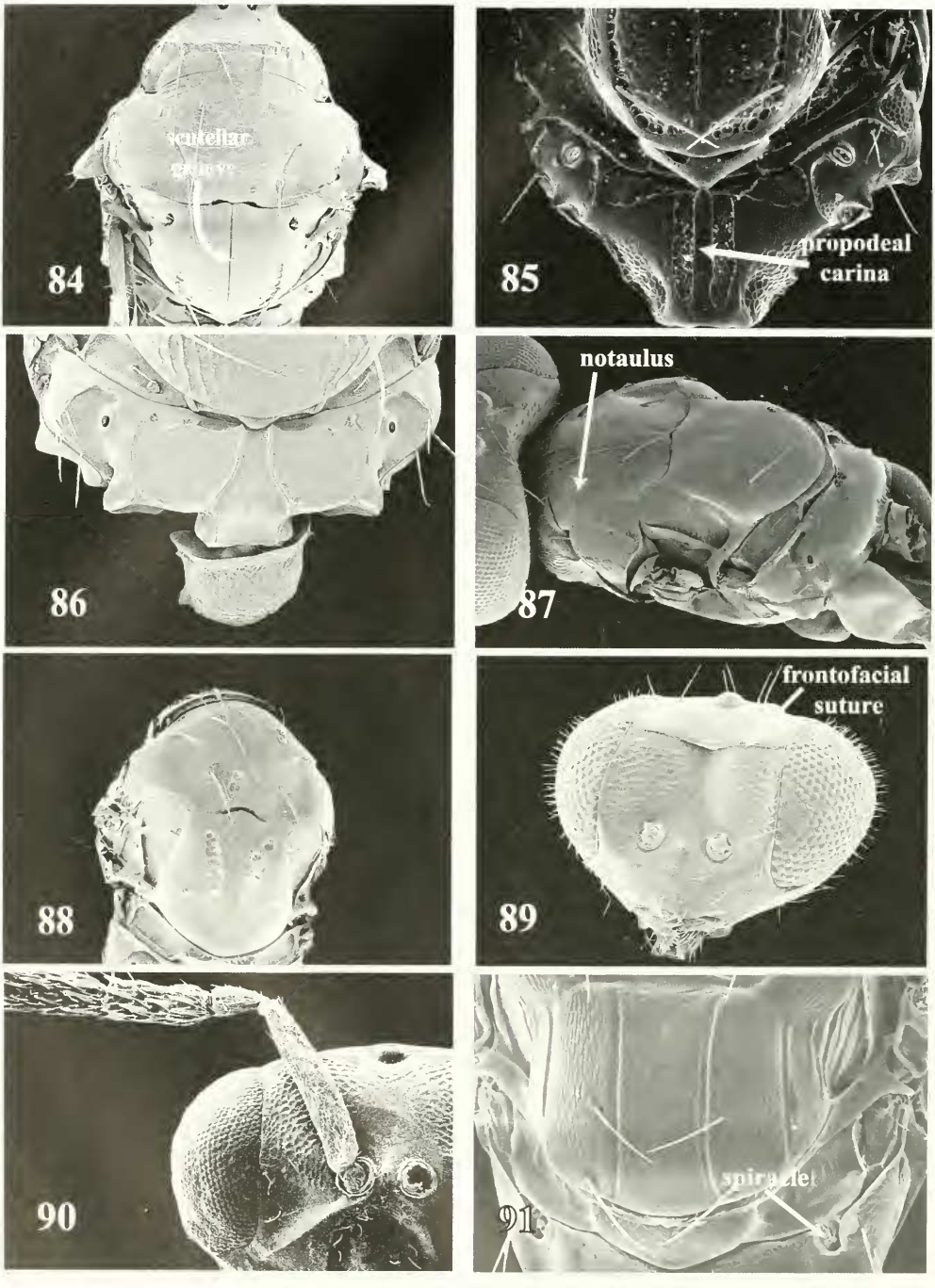
Figs. 60–67. 60–61, *Parablastothrix nearctica*: 60, face. 61, lateral mesosoma. 62–65, *Eupelmus* sp., female: 62, dorsal mesosoma. 63, lateral mesosoma, male. 64, dorsal pronotum. 65, apex of protibia. 66–67, *Brasema* sp.: 66, dorsal gaster. 67, mesotarsus.



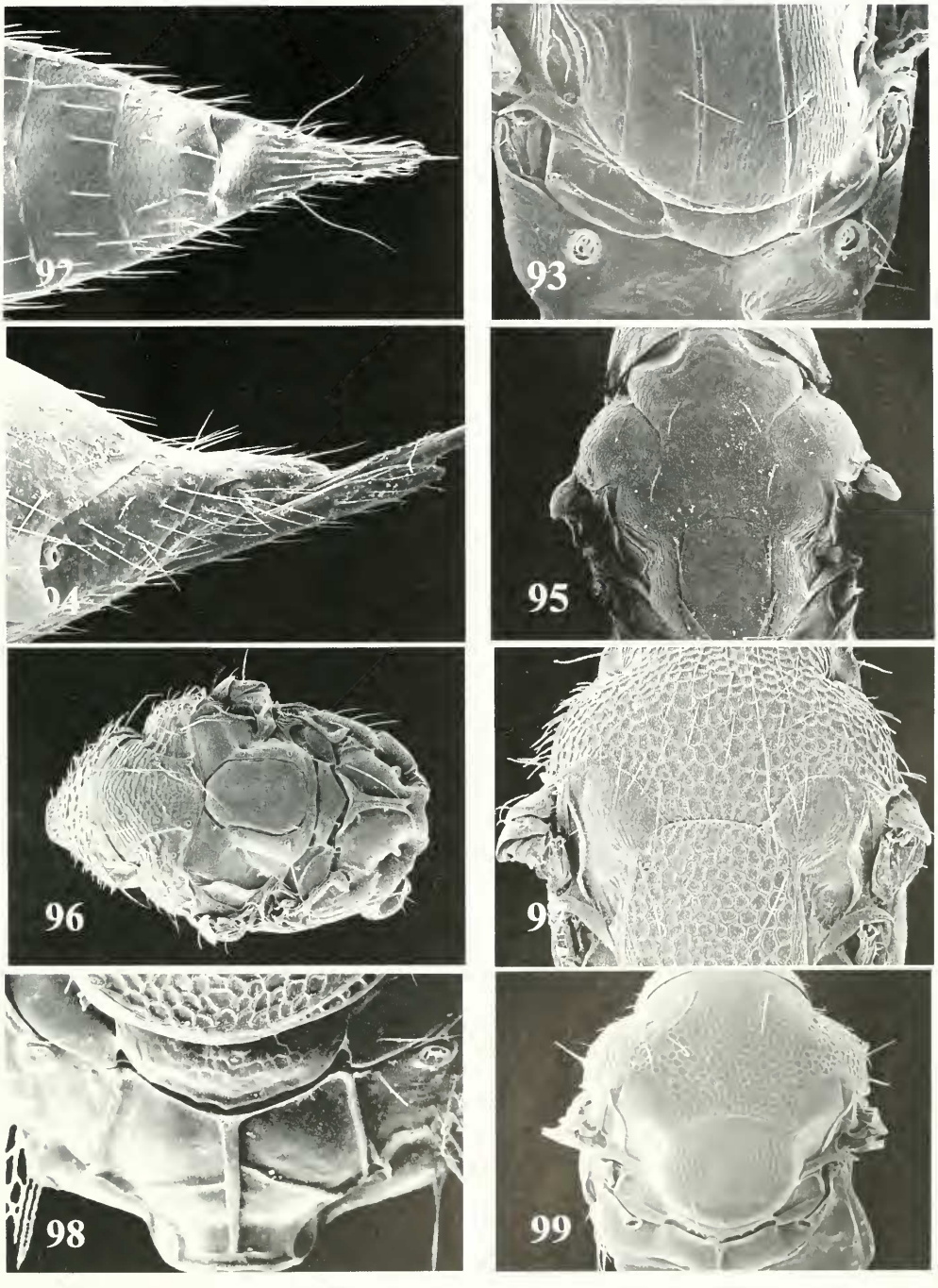
Figures 68–75. 68–69, *Eupelmus* sp.: 68, apex of gaster. 69, mesotarsus. 70–71, *Pteromalus* sp.: 70, lateral head and pronotum. 71, dorsal mesosoma. 72–74, *Halticoptera* sp., male: 72, propodeum. 73, clypeus and palps. 74, dorsal petiole. 75, *Thinodytes* sp., clypeus.



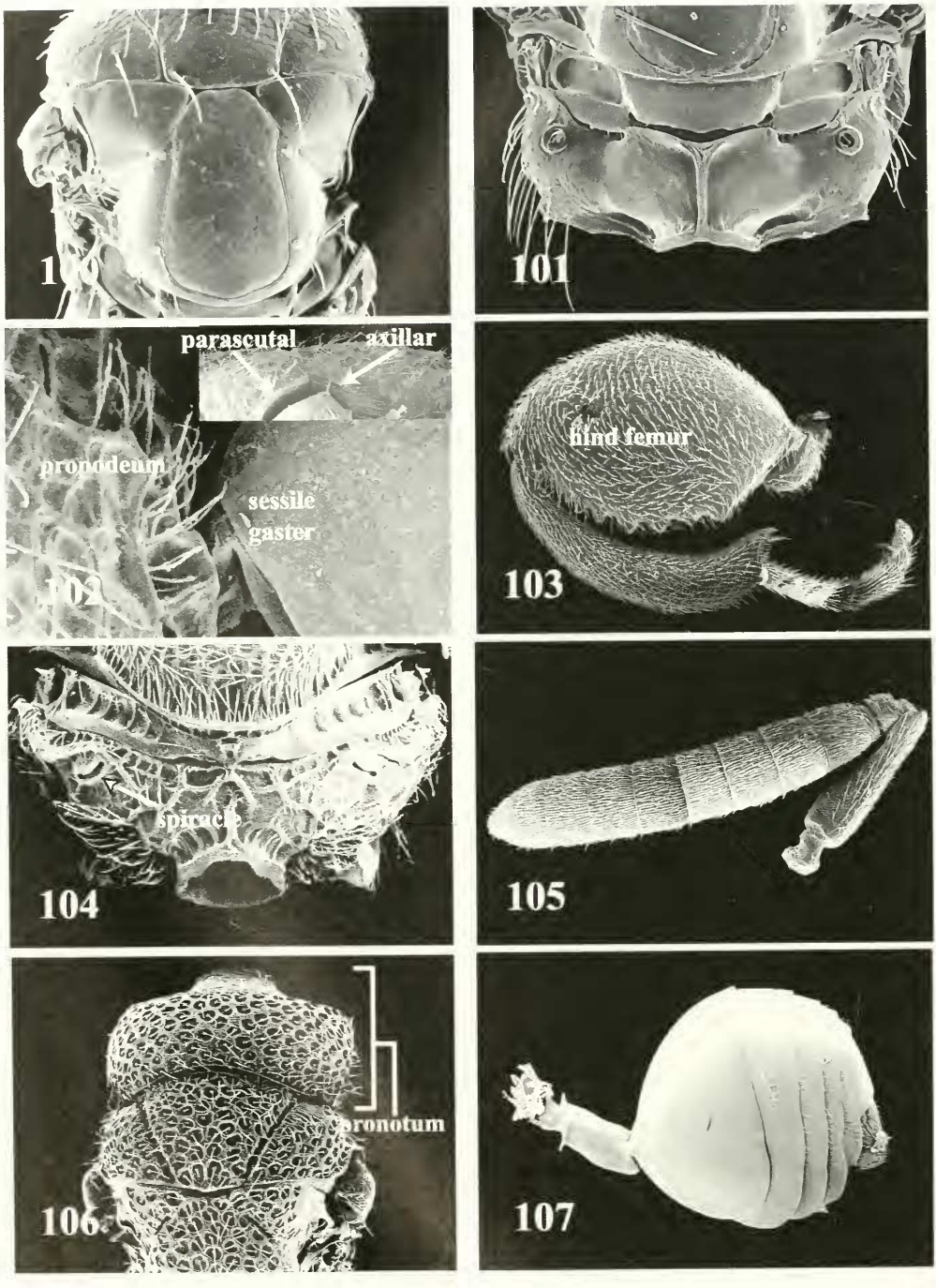
Figs. 76–83. 76–77, *Thinodytes* sp.: 76, propodeum. 77, dorsolateral petiole. 78–81, *Mesopolobus* sp.: 78, face. 79, dorsal mesosoma and gaster. 80, propodeum. 81, anterolateral mesosoma. 82, *Mauleus* sp., face. 83, *Pteromalus* sp., clypeus.



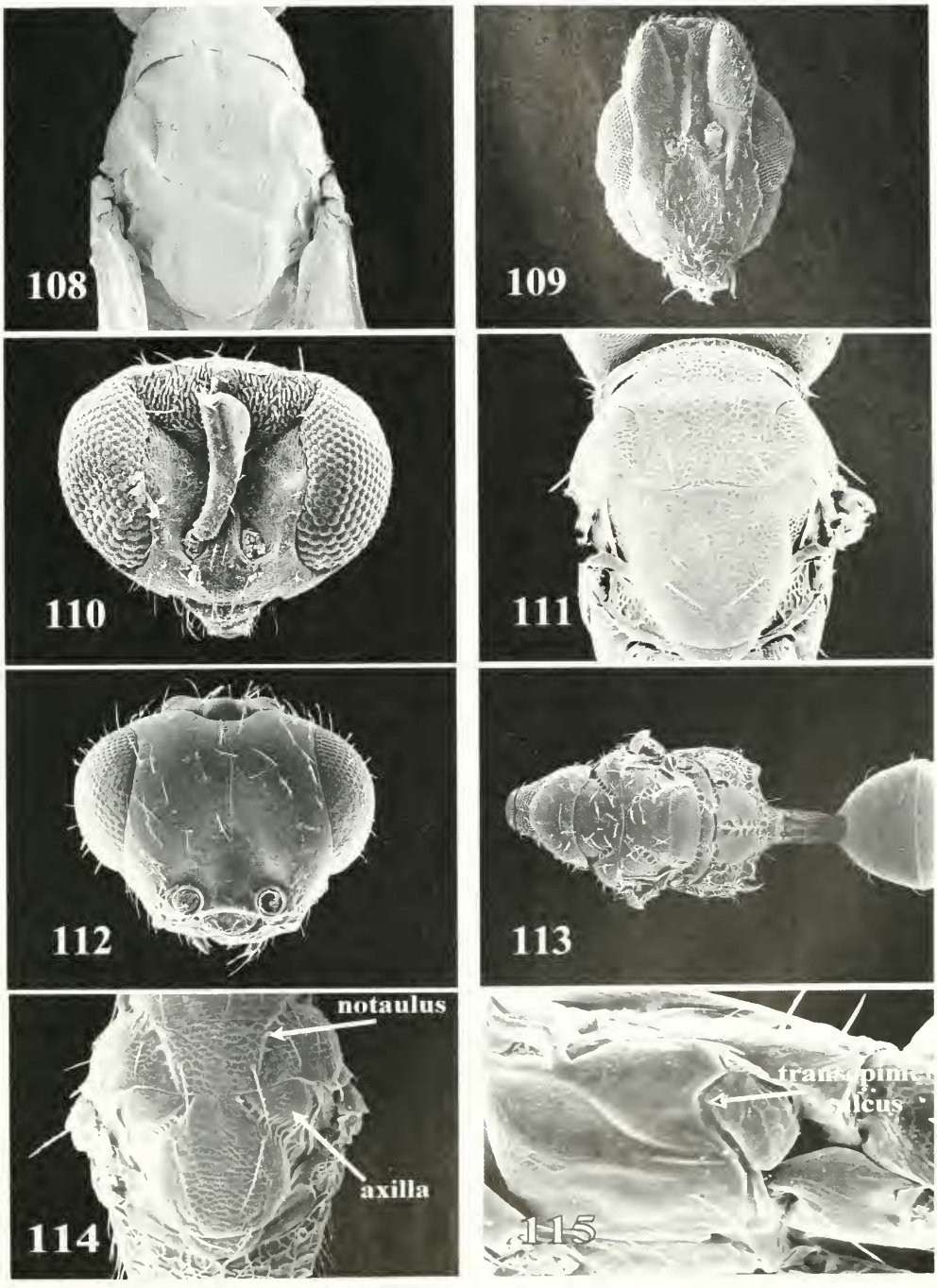
Figs. 84–91. 84–85, *Horismenus* sp.: 84, dorsal mesosoma. 85, propodeum. 86, *Pediobius* sp., propodeum. 87, *Chrysocharis* sp., dorso-lateral mesosoma. 88–89, *Achrysocharoides* sp.: 88, dorsal mesosoma. 89, face. 90, *Hemiptarsenus* sp., face. 91, *Aprostocetus* sp., scutellum.



Figs. 92–99. 92, *Aprostocetus* sp., gaster apex, dorsal view. 93–94, *Baryscapus* sp.: 93, scutellum. 94, gaster apex, lateral view. 95, *Diglyphus* sp., dorsal mesosoma. 96, *Miotropis* sp., dorsal mesosoma. 97–98, *Pnigalio* sp.: 97, dorsal mesosoma. 98, propodeum. 99, *Sympiesis* sp., dorsal mesosoma.



Figs. 100–107. 100–101, *Elachertus* sp.: 100, dorsal mesosoma. 101, propodeum. 102–105, *Brachymeria* sp.: 102, lateral view petiole; inset: junction parascutal and axillar carinae above wing base. 103, hind leg. 104, propodeal spiracle. 105, antenna. 106, *Eurytoma* sp., anterior mesosoma, dorsal view. 107, *Conura* sp., lateral gaster.



Figs. 108–115. 108–109, *Zagrammosoma* sp.: 108, dorsal mesosoma. 109, face. 110–111, *Closterocerus* sp.: 110, face. 111, dorsal mesosoma. 112–113, *Spalangia* sp.: 112, face. 113, dorsal mesosoma and gaster. 114, *Cirrospilus* sp., dorsal mesosoma. 115, *Neochrysocharis* sp., lateral mesosoma.

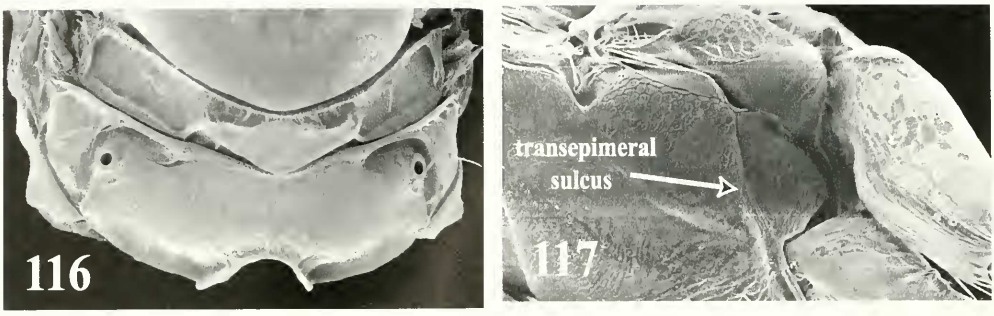


Fig. 116–117. 116, *Achrysocharoides* sp., propodeum. 117, *Closterocerus* sp., lateral mesosoma.

Subfamily Euderinae

31. Genus ***Euderus*** Haliday
(Fig. 45)

Diagnosis.—Tarsi 4-segmented. Funicle 4-segmented. Fore wing with 2–3 lines of radiating setae and with distinct row of setae ventrally in the admarginal area (Fig. 45). Notauli deep, complete.

Notes.—Yoshimoto (1971) provides a key to the species north of Mexico, and Noyes (1998) records 30 species from the Nearctic region with five of these known from California. These are primary parasites of Lepidoptera, Coleoptera, and Hymenoptera, or secondary parasites of Lepidoptera through Ichneumonoidea. The specimen reared in this study is newly associated with *Neurobathra boliartiella* Opler, a gracillariid.

Family EUPELMIDAE
Subfamily Eupelminae

32. Genus ***Eupelmus*** Dalman
(Figs. 62–65, 68–69)

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented. Mesopleuron enlarged and convex (Fig. 63) (females only). Mesoscutum with large concave depression (Fig. 62); pro- and mesocoxae separated by several times their own diameter. Syntergum varied in structure, often emarginate (Fig. 68). Fore wing usually hyaline or with longitudinal infuscate band; propodeum with mesotibia lacking oblique apical groove and dark apical pegs above base of tibial spur (Fig. 69); Gt_1 and one or more of Gt_{2-4} with posterior margins broadly or narrowly V-like emarginate.

Notes.—Noyes (1998) reported 42 species from the Nearctic region; six were found in California. The subgenus *Eupelmus* (*Eupelmus*) is cosmopolitan, but most speciose in the Nearctic where they are parasitoids or hyperparasitoids of numerous taxa of Holometabola, usually cryptically-feeding taxa. Some are known from eggs of Homoptera, Mantodea, Coleoptera, Lepidoptera and Orthoptera (Bouček 1988, Gibson 1995). The specimens reared in this study are associated with an unknown leafminer (Gelechiidae) on *Arctostaphylos glauca* Lindl. (Ericaceae) as well as *Cameraria shenaniganensis* Opler and Davis (Gracillariidae), and *Prodoxus coloradensis* Riley (Prodoxidae).

33. Genus ***Brasema*** Cameron
(Figs. 66–67)

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented. Mesopleuron enlarged and convex (females only). Syntergum in dorsal view with posterior margin truncate or slightly emarginate (Fig. 66). Fore wing usually hyaline or with longitudinal infuscate band; propodeum with plical region sublinear to quadrate, but broad and in approximately same plane as callar region; mesotibia with oblique apical groove and dark apical pegs above base of tibial spur (Fig. 67); Gt_1 and or more of Gt_{2-4}

with posterior margins broadly or narrowly V-like emarginate (Fig. 66).

Notes.—Approximately 50 species of *Brasema* are known (Gibson 1995), although many of these have yet to be removed from *Eupelmus*. Only five species are currently reported for the Nearctic region (Noyes 1998) and one of these is found in California. *Brasema* is cosmopolitan, but most speciose in the Neotropics where they are parasitoids or hyperparasitoids of numerous Holometabola in cryptic habitats. Some are known from eggs of Homoptera, Mantodea and Orthoptera (Gibson 1995). The species of *Brasema* herein are newly associated with Agromyzidae (*Liriomyza* sp.).

Family EURYTOMIDAE
Subfamily Eurytominae

34. Genus ***Eurytoma*** Illiger
(Fig. 106)

Diagnosis.—Tarsi 5-segmented. Funicle 5-segmented. Pronotum quadrate in dorsal view (Fig. 106). Body sculpture umbilicately punctate. Propodeum usually depressed or channeled medially.

Notes.—Bugbee (1967) provided a key to species north of Mexico. Of the approximately 700 nominal species worldwide, at least 92 occur in the Nearctic with dozens in California (Noyes 1998). This genus exhibits a wide host range from phytophagy (at least 4 plant families) to entomophagy (Coleoptera, Diptera, Lepidoptera, Hymenoptera, Hemiptera, Araneae) or both (DiGiulio 1997). The species reared in this study emerged from an unknown leafminer on *Penstemon caesius* A. Gray (Scrophulariaceae).

Family PTEROMALIDAE
Subfamily Miscogasterinae

35. Genus ***Callimerismus*** Graham

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented. Clypeus with three asymmetrically arranged apical denticles. Pronotum angular between collar and neck. First gastral tergum with posterior margin nearly straight; petiole less than 1.4× as long as broad and anteroventrally braced with transverse flange (as in Fig. 74). Propodeum with submedian area strongly reticulate (as in Fig. 80). Color metallic green.

Notes.—Until now, no host had been recorded for this genus (Heydon 1989) and only one species was known from eastern North America and four worldwide (Noyes 1998). The species reared in this study emerged from an unknown leafminer on *Penstemon caesius* A. Gray (Scrophulariaceae).

36. Genus ***Thinodytes*** Graham
(Figs. 32, 75–77)

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented (Fig. 32), scape usually metallic. Clypeus either with one asymmetric tooth (Fig. 75) or with three teeth (none known with bidentate clypeus), but then teeth usually sharp and with only narrow gap between them. Palps and stipites in male slender. Pronotum angular between collar and neck. First gastral tergum with posterior margin nearly straight (as in Fig. 79); petiole less than 1.4× as long as broad and anteroventrally braced with transverse flange (Fig. 77). Propodeum with submedian area strongly reticulate (Fig. 76). Color almost wholly black to metallic green. According to Heydon (1995), *Thinodytes* is characterized by its complete absence of synapomorphies defining related genera. Two genera commonly confused with *Thinodytes* are *Halticoptera* and *Mauleus*. These latter genera are recognized by having the torulus above lower eye margin, the petiole without a median carina and with its anterolateral corners sharp and enlarged (*Mauleus*), the scape usually non-metallic, the male maxilla with lamellately expanded palps and usually with another lobe on the stipites, the petiole usually with median carina and with anterolateral corners of petiole not so greatly expanded (*Halticoptera*).

Notes.—Five members of this genus are known from the Nearctic region with three of these known to occur in California (Noyes 1998). All known hosts are small Diptera living in plants as stem or leaf miners (Heydon 1995). The species reared in this study emerged from an unknown leafminer on *Penstemon caesius* A. Gray (Scrophulariaceae).

37. Genus *Halticoptera* Spinola (Figs. 72–74)

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented. Clypeus bidentate (Fig. 73). Pronotum angular between collar and neck. First gastral tergum with posterior margin usually emarginate; petiole less than 1.4× as long as broad, anteroventrally braced with transverse flange and with longitudinal carina (Fig. 74). Propodeum with submedian area strongly reticulate. Color bright metallic green.

Notes.—See discussion under *Thinodytes* for differentiating this genus from *Mauleus* and *Thinodytes*. Approximately nine species have been recorded from the Nearctic region and three from California (Noyes 1998). Records for *Halticoptera* presented here include one new host association with *Calcomyza* sp. (Agromyzidae).

38. Genus *Mauleus* Graham (Fig. 82)

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented. Clypeus bidentate (Fig. 82). Pronotum angular between collar and neck; dorsum of mesosoma as high as vertex. Gt1 with posterior margin usually emarginate; petiole less than 1.4× as long as broad and anteroventrally braced with transverse flange (as in Fig. 77). Propodeum with submedian area moderately reticulate (as in Fig. 76). Color dark metallic green or blue.

Notes.—See discussion under *Thinodytes* for differentiating this genus from *Mauleus* and *Halticoptera*. The genus *Mauleus* contains five nominal species, of which at least 3 occur in the Nearctic (Noyes 1998). Where biologies are known, they attack leafmining Diptera (Heydon 1995). The species reared in this study emerged from an unknown leafminer on *Penstemon caesius* A. Gray.

Subfamily Pteromalinae

39. Genus *Trichomalopsis* Crawford (Fig. 47)

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented. Head lacking both postgenal carinae and depression laterad of mouth; occiput with carina halfway between ocelli and foramen. Pronotal collar not or barely margined. Propodeum with distinct plicae and often with median carina. Stigmal vein subequal in length to marginal vein.

Notes.—At least 15 species occur in the Nearctic (~4 from California (Noyes 1998)) region and typical hosts are pupae of Coleoptera and Lepidoptera (Bouček and Heydon 1997). The *Trichomalopsis* reared in this study are associated with ?*Periploca* sp. (Gelechiidae) and an unidentified chrysomelid.

40. Genus *Mesopolobus* Westwood (Figs. 44, 78–81)

Diagnosis.—Tarsi 5-segmented. Funicle 5- or 6-segmented. Pronotal collar typically without conspicuous smooth strip or body with the following features: mesoscutal reticulation regular, usually without distinct setiferous punctures (Fig. 79); left mandible with 3 teeth, the right with 4. Flagellum with 3rd flagellomere anelliform, shorter than pedicel. Ocelli not very small; propodeal spiracle ovate, its longest diameter ⅓–¼ length of propodeum. One of the most poorly defined genera in Pteromalidae, often confused with *Pteromalus*, among others. *Pteromalus* has the third flagellomere ≥ the length of the pedicel and the nucha raised reticulate, while *Mesopolobus* has the third flagellomere < the length of the pedicel and the nucha at most striate.

Notes.—Noyes (1998) listed over 200 named species of *Mesopolobus* (excluding synonymies, etc.) and the several dozen species in the Nearctic region attack insects in galls of Cynipidae and pupae of Lepidoptera, Symphyta, and Coleoptera (Bouček and Heydon 1997). The new association for *Mesopolobus* is *Cameraria sempervirensella* Opler and Davis (Gracillariidae).

41. Genus *Pteromalus* Swederus (Figs. 55–56, 70–71, 83)

Diagnosis.—Tarsi 5-segmented. Funicle 6-segmented. Pronotal collar with or without conspicuous smooth strip. Left mandible with 3 or 4 teeth, the right always with 4 teeth. Flagellum with 3rd flagellomere often only slightly transverse, quadrate or oblong, as long as or longer than pedicel. Stigmal vein ⅔–⅕ length of marginal vein (Fig. 55); propodeum lacking costula and with posterior corner obtuse; pronotal collar with abrupt or round margin (Figs. 70, 83). It is difficult in many instances to differentiate between *Mesopolobus* and *Pteromalus* as both are very similar (see above), but *Pteromalus* usually has a more compact head (Fig. 56).

Notes.—Well over 1,000 names worldwide are listed in this genus by Noyes (1998) (excluding synonymies, etc.). At least 40 species occur north of Mexico on pupae of Lepidoptera, Coleoptera and their parasitic Hymenoptera. One species occurs in spider egg sacs (Bouček and Heydon 1997).

Subfamily Spalangiinae

42. Genus *Spalangia* Latrielle (Figs. 112–113)

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented, clava unsegmented. Toruli just dorsad of mouth opening (Fig. 112). Upper face with row of punctae medially. Head and mesosoma usually with deep, setiferous punctures and shiny between (Fig. 113). Petiole elongate with longitudinal carinae.

Notes.—Minimally 12 species in the Nearctic known to attack puparia of Diptera (Burks 1969), with at least six species on synanthropic flies. Four species are known from California (Noyes 1998). The specimen of *Spalangia* reared here is newly associated with *Liriomyza* sp. (Agromyzidae).

Family TORYMIDAE
Subfamily Toryminae

43. Genus *Microdontomerus* Crawford (Fig. 46)

Diagnosis.—Tarsi 5-segmented. Funicle 5-segmented. Metapleuron separated by straight line from mesopleuron, not projecting forward (as in Fig. 51). Metafemur with ventral margin minutely serrate (Fig. 46). Propodeum with two complete submedian carinae.

Notes.—Four species (6 undescribed) species in the Nearctic region, of which three are known from California (Grissell 1979, Grissell 1995, Grissell 1997) are primary and secondary parasites of Lepidoptera, Coleoptera, Diptera, Aculeata, and their parasites (Braconidae). The specimen reared during this study is associated with *Coelopocta glutinosi* (Walsingham), an elachistid.

44. Genus *Torymus* Dalman

Diagnosis.—Tarsi 5-segmented. Funicle 7-segmented. Metapleuron separated by sinuous line from mesopleuron, projecting forward into mesopleuron (Fig. 52). Metafemur lacking teeth (as in Figs. 36–37). Fore wing with marginal vein at least 7.0× as long as stigmal vein (Fig. 40).

Notes.—Over 320 species of *Torymus* occur worldwide and keys have been provided by Huber (1927) and Grissell (1976—part) to the approximately 99 species north of Mexico. Approximately 35 species are recorded by Noyes (1998) as occurring in California. Species of *Torymus* usually attack gall-forming Cynipidae, Cecidomyiidae or are phytophagous. The

single male specimen reared in this study is associated with an unknown leafminer on *Arctostaphylos glauca* Lindl. (Ericaceae).

QUESTIONABLE RECORDS

Superfamily Chalcidoidea
Family SIGNIPHORIDAE
Genus *Chartocerus* Motschulsky

Members of Signiphoridae are most frequently reared from Hemiptera, Aphididae and Psyllidae, but are also known to be hyperparasitic through Hymenoptera and Diptera. While *Chartocerus* are primarily obligate hyperparasitoids of the aforementioned taxa, they also have been recovered from puparia of Diptera (Chamaemyiidae (Woolley 1997), Drosophilidae (Hanson 1995), and Chloropidae (Erdös 1957)). A single specimen was reared from a blotch leaf mine on *Quercus* sp., which was mined by an unknown species of leafminer. Though not impossible in terms of hosts associations, we prefer to place this specimen as questionable both until a definitive host record becomes available and because this was the only signiphorid recovered in well over 15,000 rearings included in this study.

Family MYMARIDAE
Genus *Gonatocerus* Nees

The members of this genus are known to attack eggs of Cicadellidae and Membracidae (Huber 1997). Although supposedly reared from a species of *Liriomyza* mining leaves of *Datisca glomerata*, we believe that this specimen emerged from undetected contamination rather than the agromyzid.

Family PTEROMALIDAE
Genus *Lyrcus* Walker

Over 15 species are known from the Nearctic (Heydon and Bouček 1992). There is only one described species in western Canada and western United States and several undescribed species. The specimen in this study is associated with *Liriomyza* sp. on *Salvia mellifera* Greene. This species is known from gall-forming Cecidomyiidae and *Rhopalomyia* spp. are known to form tubular leaf galls on western *Salvia* spp. These galls are often inconspicuous and may have been overlooked as a contaminant giving rise to the *Lyrcus justicia* (Girault) specimen.

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